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"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH

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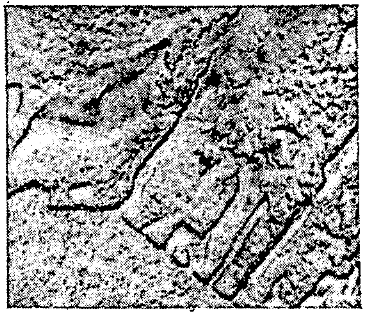

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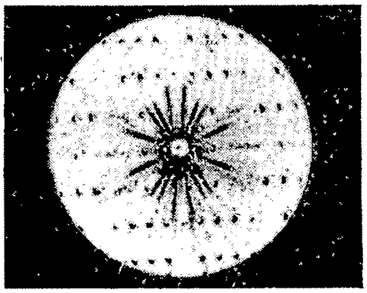

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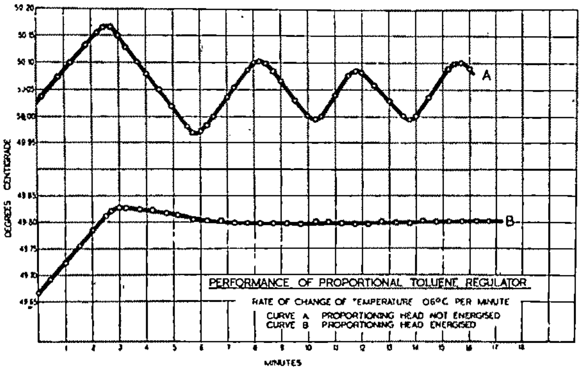

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FREEDOM OF THE PRESS

THE lively debate on the control and ownership of the Press in the House of Commons on October 29, which issued in a resolution urging the appointment of a Royal Commission to inquire into its finance, control, management and ownership, touched on matters that lie very near the heart of democracy, and which may have a closer bearing on the advancement of science than a superficial examination would suggest. It is not that there is any great enthusiasm for a Royal Commission. On the contrary, few suggested that a Royal Commission could add significantly from the fact-finding point of view to the information already collected in the report issued in 1938 by Political and Economic Planning, and Mr. Douglas Jay was not alone in failing to see that such an inquiry would produce any very substantially useful results. Even if other facts were discovered, he questioned whether they would throw more light on the really essential question whether the present financial control of the Press is interfering with freedom of expression.

That central issue was clearly recognized in the debate. Few questioned that the general tendency for the great majority of newspapers to fall into the hands of a very few men constitutes a serious threat to political democracy. That was explicitly stated by Mr. Haydn Davies in moving the resolution: Could we, or could we not, have real freedom of the Press in a system of combines and chain newspapers ? But among those who agree with Mr. Davies that we cannot, there are still those who doubt whether Government action such as a Royal Commission might invite could be effective without involving worse dangers. What is wrong is not so much the private ownership of the Press, as the use that is being made of that ownership.

If, however, the existence of abuses is recognized, there is little indication of clear ideas as to how they are to be checked. Moreover, as Mr. Driberg pointed out, it is not solely a question of freedom of expression for the writer, but of a part of the general liberties of the citizen, who is entitled to receive accurate news and fair comment. However well-founded may be the belief that the citizen is not getting a full measure of either, no one succeeded in the debate in showing how that measure could be extended without either a direct curtailment of the liberty of the Press or an extension of Government control.

What is required, in fact, is some very clear and constructive thinking at just this point, and it can scarcely be expected that a Royal Commission will go beyond the fact-finding from which such thinking must start. No doubt a further inquiry will again emphasize the interference with freedom of expression which comes from the present law of libel ; and Mr. Mallalieu suggested that a Royal Commission might well look into the question of the way in which freedom of expression and of discussion is hindered by the tendency to exclude the Press directly or indirectly from the proceedings of local councils. Such matters, however, like the better training of journalists and the higher standard of writing for which Mr. Mallalieu and Mr. Derek Walker-Smith both pleaded, are scarcely matters on which a Royal Commission can formulate proposals. They must come in the main from the professional associations of journalists or from that body of informed public opinion which, recognizing the natural restraints on freedom which are inherent in an organised community, realize also the value of standards evolved from within rather than constraints imposed from without or above.

It could not be said that the opinion expressed in the debate was entirely pessimistic. Some speakers suggested that the position is already better than two decades ago, and Mr. Walker-Smith at least anticipates both advances in technique and in presentation from the production side, and also in the standards which a people whose mind is on the march would demand. Though this comes near the core of the problem, other speakers in the debate showed little consciousness that this whole question is bound up with the wider one of informing the public and assisting the formation of a sound public opinion in a democratic society, to which both broadcasting and the information services which a Government is bound to use have also important contributions to make.

It is the great merit of Francis Williams's "Press, Parliament and People" (W. Heinemann, Ltd. London, 1946. 8*s*. 6*d*. net) that he sets all these factors in their true perspective, and his book should certainly assist in assessing the value of the contribution which a Royal Commission can make. In fact, it is difficult to believe that the report of a Royal Commission could stimulate the constructive and creative thinking, which is our primary need, half so effectively as this lively and timely book. The key problem is not so much that of the ownership and control of the Press, as that of how a democracy can adjust itself to the great and inevitable increase in the concentration of power in the hands of a Government without endangering the personal liberties inherent in a democracy.

That thread is clearly visible in what might well have seemed an interminable debate on the address to the Throne, which well illustrates both the need on the Government side to inform the people of what it is doing in terms that they can understand, and on the other hand the balancing need for highly informed and critical watchfulness on the part of the Press and other instruments of public opinion in order to safeguard the liberties of the individual. As Mr. Williams truly observes, many of the problems of domestic reconstruction are so complex that an almost entirely new approach to the task of informing and explaining policy will be required if the great mass of ordinary people upon whose positive co-operation the success of these policies depends are to feel themselves participants in a common adventure. Moreover, not only is there a need for less secrecy and more information in home and in foreign affairs alike; the debate on certain topics such as the 'closed shop' also underlines the force of Sir Walter Layton's contention in his pamphlet, "Newsprint: a Problem for Democracy", that the present size of the Press, with the consequent limitation of knowledge of public affairs, constitutes a severe handicap to the country. On the evidence of this debate alone, it might be added that it constitutes a danger to personal liberties and to individual justice, apart from the fact that, as Sir Walter observes, "the press of a country is neither healthy nor truly free unless its circulation can respond to the impact of public opinion".

Mr. Williams has much that is pertinent to say about the British press censorship as it was exercised during the War. Emphasizing that it was always voluntary, he points out, too, that it was one of fact and not of opinion. It existed to advise the Press as to which facts could and which could not safely be published without running the risk of giving the enemy information of value in the prosecution of the War. It had no authority to advise the Press as to the opinions they should or should not express. Moreover, while Mr. Williams from his inside knowledge pays a high tribute to the liberality with which the British press censorship was on the whole conducted, he is convinced that censorship of any kind is an instrument to be used only in the most extreme circumstances and with the most rigorous safeguards, and that no Government can be trusted with power to control the Press or the publication of books. Even in the circumstances of war, more damage was done, on the whole, when newspapers accepted directives on policy outside the strict and narrow limitations of press censorship than when they ignored them.

That opinion is well substantiated by Mr. Williams's account of the failure of political censorship during the War. Whereas in the technical and factual field the machinery established for joint consultation and co-operation made for the elimination of clashes and contributed to the success of the censorship, in the political field he argues it cannot be justified. It represents a confession by the authorities of their refusal to trust the people to form sound opinions, and of their unwillingness to allow them to judge between conflicting views and to abide by the result as democracy requires.

The growth of public relation and information services is a much bigger question. Mr. Williams points out how that growth has been accentuated by the War and still more by the measures of social reconstruction to which Britain is now committed; and he shows that Government information services, including such research units as the Social Survey, have a permanent and essential place among those instruments which the executive in a democracy requires to carry through positive measures essential to national and international advance, while the democracy retains those checks upon the exercise of undue authority, those balances and counterbalances which are equally essential to safeguard liberty. We are here straying into that important problem of the organisation of government machinery, and it must suffice to note with Mr. Williams that publicity is no substitute for good administration; it is only effective when the administrative measures it seeks to explain are sound in themselves. What is essential is that the version of a measure or policy placed before the general public by the information services of the Government shall be fair and unbiased. Public judgment must be formed on the true facts, and not on a partisan presentation of them.

That is an argument for the constant scrutiny of the activities of Government information services, but not for their restriction; and one basic reason for Sir Walter Layton's plea for a more generous supply of newsprint is to enable the Press to play more effectively its part in such scrutiny, and in averting the further danger that under the guise of straightforward explanation and instruction the public may be led to accept as facts what are highly debatable propositions. This is a point which was missed by the unofficial 'working party' under Sir Richard Gregory's chairmanship which prepared for the recent Empire Scientific Conference a paper on the "Dissemination of Scientific Information to the General Public"; but it is one to which scientific workers need to give far more attention. It is one aspect of the obligations which their loyalty to truth demands in that partnership with science as a part of the social contract which in Burke's view constitutes the State. Beyond that it is a duty which they owe to science itself. A bad book was ever the enemy of other books, and in the conditions of to-day it has to be remembered that publication of a book or a periodical which does not meet those high standards of accuracy and impartiality which science rightly demands, may well be hampering the publication of another which does.

That is no reason for return to a censorship. The argument of Milton still stands. But it is imperative that the reviewing of books and the scrutiny of scientific publications of all kinds should be searching and objective, and that neither loose nor tenditious writing, inaccuracy, nor verbiage should escape the criticism it invites. It would be easy to instance recent scientific and technical books which have been too lightly handled in this respect. If the proceedings of the Royal Commission and Mr. Williams's book emphasize that scientific workers have real responsibilities in this field, much good will have been done; and possibly one way opened up for easing that serious position which the shortage of scientific and technical books is causing. It is true that increasing use is being made of broadcasting for the dissemination of scientific news, and scientific men in Britain are showing far more signs of awareness of the immense influence which the B.B.C. can exert in educating and informing the public on scientific and technical matters. The way in which this influence could be exerted and the use of this instrument, by which the mass of the people can learn more about the world in which they live and something about the purpose and significance of the policies their Government has adopted, were among the reasons prompting the desire for an independent inquiry on broadcasting policy which the Government rejected in the White Paper last July.

While, however, broadcasting is one important way in which information on Government policy or on scientific and technical matters can be disseminated, it cannot either replace the printed book or paper, or provide the check on executive action which is the other half of the democratic problem. That part of the problem relates to the machinery of government; this cannot be discussed further here, except to insist once more that any effective machinery of government must be equipped with adequate means of both keeping the executive in touch with the trend of public opinion and of providing the country and the world in general with an honest and truthful picture of the position of the nation and the reasons for its policy. Any form of censorship or control that would restrict the seeking out and disclosure of truth or dam the flow of knowledge, either within any one nation, or between nations, is a fatal bar to the efficiency of democratic government and the understanding between peoples on which all our hopes depend. It is only by a readiness to seek and publish the truth whatever its implications, to enter into frank debate between governed and governing, and between nation and nation, to challenge, to criticize and propose, and to offer to the test of world opinion the principles by which we seek to guide our affairs, that, as Mr. Williams concludes, freedom can flourish.

Until the terms of reference of the Royal Commission are published, it is, of course, not known whether or not its inquiry will embrace the scientific and technical Press as such. Indirectly at least it is clear that the whole question touches the dissemination of knowledge and the advancement of science very closely. Some of the particular problems which it offers to men of science have already been indicated. They on their side have repeatedly emphasized in the past year how closely not merely the advancement of science but also the future of civilization depend on the restoration of the fullest freedom of communication within and between the nations. There is in Mr. Williams's book, no less than in the debate just noted, much that should stir them to the constructive thinking on the organisation and use of information services which the functioning of democracy and the needs of science both demand.

HISTORY OF MODERN CHEMISTRY

Modern Chemistry

Some Sketches of its Historical Development. By A. J. Berry. Pp. x+240. (Cambridge: At the University Press, 1946.) 10*s*. 6*d*. net.

THIS is a history of chemistry that is different. Its title and sub-title indicate quite a new approach to the treatment of the subject. A chemistry curriculum is a crowded affair nowadays, partly because of the rapid advances and immense ramifications of chemistry, and partly because it is not yet certain, in these post-war years, just how the curriculum should be arranged. In this changing period the attempt is almost inevitably made to give students as much information as they can digest, with the result that many scarcely realize that all these advances have been made by men many of whom are still alive and still contributing to the science. With undergraduates it is especially important that this human side of chemistry should be brought to the fore, even at the expense of selection. Mr. Berry has set out to accomplish this difficult task of attaching a name or names to these achievements in chemistry. It is not an easy task, for naturally personal predilection is bound to occur, but it is well that the British contribution (and at times even the Cambridge contribution) should take its proper place among that from other countries.

An honours student will already be familiar with much that is in this book, but he will be none the worse for re-reading it from a rather different point of view—much of the detail is omitted and therefore the story has a continuity that is lacking from the average formal text-book. The physical side of chemistry is more suitable for Mr. Berry's treatment, and consequently we find chapters on atomic theory, electro-chemistry, stereo-chemistry, radioactivity, isotopes, gas reactions and the nature of solutions. There might have been more, but the variety of topics encompasses most divisions of physical chemistry. In short, the book forms an excellent companion to a good introductory text in physical chemistry, easily read and assimilated by any student even though his studies are already full. Mr. Berry is to be congratulated on putting physical chemistry of the last fifty years into a true historical perspective in a pleasant and painless manner.

H. W. MELVILLE

INTRODUCING SCIENCE

Frontiers of Astronomy

By Dr. David S. Evans. (Sigma Introduction to Science, 1.) Pp. 175+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

Science versus Cancer

By Dr. I. Berenblum. (Sigma Introduction to Science, 2.) Pp. 116+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

Electrons in Action

By Dr. J. G. Daunt. (Sigma Introduction to Science, 4.) Pp. 151+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

Power

By Dr. Martin Ruhemann. (Sigma Introduction to Science, 5.) Pp. 123+8 plates. (London: Sigma Books, Ltd., 1946.) 6*s*. net.

THE four slender volumes listed above are the first issues of a new series which, under the general title of "Sigma Introduction to Science", aims at raising and satisfying a thirst for scientific knowledge among the general public. The volumes are uniform in format, with that rather dreary-looking make-up to which we have, unfortunately, had to accustom ourselves in this austerity era. Each is illustrated with a set of excellent plates; and each is priced at 6*s*., which seems rather high, if the publishers are aiming at a really extensive circulation. None presupposes any previous knowledge of the subject, and all are free from mathematical equations, at any rate in the text. (Dr. Daunt, after struggling manfully against the temptation through 141 pages, does eventually succumb so far as to quote Ohm's law in an appendix.)

Here the similarities end. Though it is convenient to speak of the non-scientific reader, it is well to remember that since the term applies, unfortunately, to the vast majority of our fellow-countrymen, it embraces every grade of intellect and every variety of interest. Genius itself could scarcely produce a treatise which would satisfy the needs of so heterogeneous a company. An author must select his own company from the mass; and the present authors do not seem to have come to any agreement about the audience they are addressing. There is, perhaps, no particular reason why they should. This divergence of treatment does, however, make it impracticable to give a general recommendation to the series. Each volume will, no doubt, find a clientele; it would be an exceptionally undiscriminating reader who would find them all acceptable to him.

It was almost inevitable that the first introduction should be to astronomy. The public appetite for popular astronomical works appears to be almost insatiable, and for very obvious reasons. "Frontiers of Astronomy" is a straightforward matter-of-fact account of the present state of astronomical knowledge in most of its branches. There is a chapter on the solar system, two on stars in general, another on solar physics; novæ and cepheid variables are not neglected, and galaxies, nebulæ and the like also receive a perhaps somewhat scanty treatment. There is also an excellent chapter on astronomical instruments. Dr. Evans has a talent for clear statement and orderly arrangement, and has had, moreover, not a little experience in the popularization of science. Though necessarily highly condensed, the treatment is clear and logical, and the reader who is prepared to give it the requisite attention will find that the book provides a very sound introduction to a very extensive science.

The reader who has been brought up on earlier popular astronomy should perhaps be warned, as the author indeed warns him in a foreword, that the purpose of the book is to provide information, not to discuss its philosophical or religious implications. Unfortunately, Dr. Evans, in his reaction against what one may call the Jeans–Eddington school, has swung too far in the direction of the Gradgrind philosophy ("You are never to wonder, Louisa!"), and even purely scientific speculations on the universe are often dismissed too summarily with the statement that they are not proved. The framing of hypotheses is the ultimate aim of the scientific worker and the method by which he works. A little more indulgence in this direction would not only have made the book less arid, but would also have given a more balanced view of the subject.

"Science versus Cancer", the second of these 'introductions', is a wholly admirable book and will, we hope, receive the widest possible circulation. The problem of cancer is one in which we are all, quite literally, vitally interested; but there is no subject on which apparently well-substantiated rumours are more prevalent, and authoritative information is more difficult to come by. "What is cancer?", "Is it on the increase?", "Is it hereditary, or is it due to environment?", "Can it be prevented, and is there any cure?" These are questions which are constantly being asked, and sometimes being answered too, with more assurance than knowledge, both in conversation and in the general Press. It was high time that a simple, comprehensible and accurate statement of facts about cancer, so far as they are known, should be given to the public, together with the evidence on which they are accepted. Dr. Berenblum, in writing this little book, has performed a real public service.

It is not easy for a medical specialist to address the general public on his speciality. He has to hold the balance between arousing unjustifiable hopes and raising unnecessary and paralysing fears. Dr. Berenblum has a steady hand, and a sound judgment, and the balance in this case swings true. As a factual statement of the present position of our knowledge about this most deadly of human scourges, "Science versus Cancer" can be warmly commended.

The book, however, goes further than this. It provides, as the title implies, a most admirable précis of the history and progress of cancer research; surely one of the most difficult, baffling and fascinating fields of investigation ever explored. "One sometimes hears it stated that the layman is only interested in the practical results of research," writes Dr. Berenblum in his preface. ". . . If this is true, it is the result of bad education, and is to be deplored. . . . There is a romance of science which stimulates the mind and satisfies the soul; it also happens to be the surest approach for one's understanding of the truth." This is admirably said, and the editor of this, or any similar series of publications, might well consider issuing it as a general directive to all his contributors.

"Electrons in Action" is not a very apposite title for Dr. Daunt's little book. By a convention, which may be illogical but is now well established, it leads one to expect an account of the behaviour of electrons in the free state—in other words, an introduction to the science of electronics. What we have, in fact, is a descriptive sketch of the basic principles and phenomena of electricity and magnetism, covering (so far as such a large subject can be covered in 150 pages) the whole field from elementary electrostatics to radiolocation. The treatment is entirely non-mathematical, and the author has been at some pains to avoid, so far as possible, the use of technical terms. Imagery and analogy largely take the place of scientific argument. Analogy can be a dangerous tool, and some of Dr. Daunt's analogies seem to have been selected more for their entertainment than their didactic value. His picture of a magnetic field as a dense forest of pine trees, and electrons as little men who are terrified of the gloom and try to get out as quickly as possible, is definitely misleading. Electrons are not "terrified" of magnetic lines of force; on the contrary, they tend to describe circles around them, and Dr. Daunt's electronic men, so far from rushing out of the forest the nearest way, would tend to play ring-a-ring-o'-roses around the trees.

Dr. Daunt's material is well selected, and he keeps a firm grip on the development of the subject. The treatment is more elementary than that of the two preceding volumes of the series, and the author seems to have in mind a class of reader for whom the elementary notions of science have to be made very clear and simple. Within these limits he achieves probably as good a picture of the main outlines of the subject as can be attained without the use of some mathematical argument.

The author of "Power" has, in our opinion, missed an opportunity. There is a definite need for an authoritative, well-documented and widely comprehensible sketch of the power resources of the world, on which our present civilization is built. Without some knowledge of this subject it is impossible to plan intelligently either an Empire or a cottage, and a suitable book on the subject would be widely welcomed. Dr. Ruhemann could, we believe, have written such a book. He knows his subject, and much of the information which we should like to have is, in fact, to be found in his pages, though the search would be less tedious if he had provided the book with an index. Unfortunately, Dr. Ruhemann seems to have formed an unduly low opinion both of the seriousness and the mental capacity of his potential readers, and has adopted a style which is not merely conversational, but also, in places, positively facetious. We do not think, for example, that he adds either clarity or interest to his account of the Rankine cycle by calling the water molecule "George", and having his illustrator picture him (or it) as a little black bottle imp with golliwog eyes. The drawing of the steam engine would, in fact, have been of more assistance to the reader if the artist had left "George" out and put in the essential valves instead. (Incidentally, the whole policy of illustrating the series with humorous sketches is one which deserves reconsideration.)

When he is not striving after humour, Dr. Ruhemann can be both lucid and informative. He has selected his material well, though there are topics on which one would be glad to have the data on which his pronouncements are based. The best utilization of power for human welfare involves considerations other than those of engineering efficiency, and if Dr. Ruhemann (in common with engineers in general) wants the public to "change its habits" he must produce evidence. Would it be presumptuous to suggest that he should read Dr. Berenblum's "Science versus Cancer", and then reconsider his policy? Science can be made fascinating, without invoking the doubtful aid of the comic muse. J. A. CROWTHER

AN ENCYCLOPÆDIA OF PSYCHOLOGY

Encyclopedia of Psychology
Edited by Philip Lawrence Harriman. Pp. ix+897. (New York: Philosophical Library, Inc., 1946.) 10 dollars.

PERHAPS the fairest way of judging a work of this kind is to consider the relative amounts of space allotted to different topics. Considered in such a way, the present volume presents a somewhat queer picture. "Counseling in Student Personnel Work" occupies six pages, "Memorisation" rather less than two not particularly effective pages of a general article called "Genetic Psychology". "Experimental Psychoanalysis" and "Experimental Abnormal Psychology" receive together more than double the space allowed to "Experimental Psychology". "Porteus Maze Tests", no doubt excellent devices of their kind but after all not the only ones, get eight pages all to themselves, and "Lie Detection" has just about the same prominence as "Learning". "Rat in Animal Psychology" absorbs thirty-two pages, "Industrial Psychology" two and a half. "Semantics" (Language) runs to thirty-four pages, and "Intelligence Testing and Tests" to four. Speaking generally, problems of a pathological order receive very much more attention than anything else.

There seems a notable absence of plan, as if authors were more or less picked and then left 'to get away' with their particular pet topics. This works well enough at times, and at others gives rise to odd results, as in a rather detailed discussion of "Climate and Human Behavior" which, among other things, observes that "The hot drought phase is the typical season for despots, dictators, communism, totalitarianism, Gestapo, pogroms, fascism and decadence in general".

The writing is very uneven, but extremely rarely distinguished. With some exceptions the factual material is correctly and concisely reported. At the same time, it is in general highly selected, with an immensely strong bias towards the writing down or omission of anything that is not American.

The editor says that this encyclopædia is intended to serve the needs of three classes of people. First, there is the expert investigator who wants to find out the facts about topics of research which lie outside his own field. Well, such a person will no doubt have a background for critical evaluation and can look after himself. It seems likely, however, that most investigators will want to go where they can get both fuller and better information. Second, there are undergraduates and graduate students who have heard things mentioned in passing, by their lecturers, and want to discover more about them. The book is of far more doubtful value for these, because most of them will lack the critical equipment needed to appraise a large bulk of its contributions. Third, there are the people who want to know what are the trends in current psychology. Whether the book adequately or clearly represents these trends and whether in any event the trends can be properly understood without a much wider setting than can be attempted in a large series of short and shortish articles, many of them extremely restricted in scope, could obviously be a subject of long debate. One thing, however, seems plain. The last seven years have made a lot of difference to psychology, but this is far from obvious so far as the effort of the present volume is concerned.

For trends alone, a smaller book, with longer, better informed and much more international surveys of a few outstanding developments, would be preferable. For a genuine psychological encyclopædia—if this is required—a very much larger volume or succession of volumes could alone fill the bill.

F. C. Bartlett

UNIFICATION OF ALGEBRA

College Algebra

By Prof. A. Adrian Albert. Pp. xii+278. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 14*s*.

In one sense, it is somewhat surprising to find how little progress has been made, during the past fifty or sixty years prior to 1939, in the presentation and content of many subjects taught in schools and colleges. In some directions there has been a considerable advance, notably in experimental science, but in mathematics the forward movement has been much slower. Our methods and subject-matter seem to be securely tied up in the bonds of tradition. Yet, all the time, a great and evolutionary force has been quietly at work; this has eventually inspired the necessity for a new outlook and a corresponding change in the *modus operandi*. The Second World War has contributed considerably to this onward sweep, for it has revealed in no unmistakable manner how far behind we are. It must not be forgotten that it took a long time to replace Euclid by modern geometry, as well as to break down the artificial barriers erected by tradition between the various compartments into which mathematics was originally divided. It is, for example, not so long ago that the student of arithmetic and pure geometry was denied any application of algebra to those subjects. Happily, those days have gradually passed away, yet much remains to be done. Only recently, the Mathematical Association devoted much time to a discussion of reforms in the school certificate examinations. As a result, it advocated considerable revision in the syllabuses prescribed by the examining authorities—less formal algebra and geometry, and a closer co-ordination between geometry and trigonometry.

But the evolutionary spirit has also penetrated the subject-matter itself. Newer conceptions are demanded which will not only develop a more coherent unity in mathematics generally, but also in the compartments themselves. In the case of algebra, for example, it asks: Is algebra, as taught to undergraduates, regarded as a complete entity, or is it made up of a collection of seemingly unrelated topics? Prof. Albert, who is well known for his outstanding research on algebra, declares that the time is ripe for the subject to be presented as a unified whole instead of a miscellaneous collection of isolated topics; hence this new and inspiring work on "College Algebra". As he pointed out in an earlier volume entitled "Introduction to Algebraic Theories" (1940): "During recent years there has been an ever increasing interest in modern algebra, not only of students in mathematics, but also of those in physics, chemistry, psychology, economics and statistics".

"College Algebra" formulates a standard minimum of requirements which emphasize that algebra has a basic unity. The first three chapters are devoted to number systems, and include permutations and combinations, since these "involve nothing but counting". The fourth chapter deals with the purely algebraic theory of polynomials and rational functions. In Chapter 5, on identities and applications, the binomial theorem, summation formulæ and the progressions are treated in logical sequence and with great clarity. The sixth and seventh chapters are concerned with equations, both in theory and practice, while in Chapter 8 the algebraic theory of vectors and linear equations is linked up with trigonometry and analytic geometry. Finally, in the last two chapters, matrices, determinants and linear systems are discussed. It should be mentioned here that the author regards Chapter 10, devoted to matrices and quadratic forms, as a pedagogical experiment, since his personal experience has shown that the "theorems and techniques can be taught to immature students if no attempt is made to derive the results". Thus the text is presented in this form and should be useful to mathematical economists and psychologists.

As in all Prof. Albert's books on algebra, the subject-matter is arranged with consummate skill and written with great clearness, with the laudable desire of providing a sound foundation upon which to build an intelligent course in the calculus. The order of treatment may seem a little unusual at first, but the book tends to open a new epoch in the presentation of algebra as a new and rigorous approach to the subject, and notably in the emphasis placed upon knitting together the various topics into a fundamental unity.

It would be both interesting and progressive to see a school algebra fashioned upon similar principles.

F. G. W. Brown

Textile Design and Colour

Elementary Weaves and Figured Fabrics. By William Watson. Fifth edition. Pp. xii+513. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1946.) 25*s.* net.

THE author, in this edition of his book, has revised the earlier editions and added further chapters bringing his subject-matter up to date. The volume is, in consequence, more interesting and comprehensive and, because of its wider scope, more likely to have a general appeal.

In the earlier chapters, a detailed and well-illustrated description is given of all the simpler fundamental weaves requiring one warp and one weft, which makes this portion of the book particularly suitable for the young student or for those wishing to revise their knowledge of fabric structure. Herein, one finds all the structures clearly defined from plain weave, twills, satins, sateens, to bedford cords and piqués.

The second portion of the book, which describes the light and pigment theories of colour and their simple application to woven textiles, is sound, as are the chapters dealing with the simpler jacquards and the figured fabrics woven thereon. The author presents, in a lucid manner, the method by which jacquard designs are produced from the sketch, and developed through point paper drafting to the woven fabric.

But it is the latter part of the book which the more experienced reader will find valuable. To anyone connected with the textile industry, the glossaries of yarns, weaves and fabrics are most useful as sources of reference. The chapter on the manufacture of rayon, outlining as it does the processes for producing the different types, and the section on recent developments in fibres and yarns are particularly interesting, especially when dealing with the characteristics and definitions of the new synthetic yarns. The subject of cloth firmness, with the necessary calculations for finding the ideal cloth particulars, or any required changes either in sett or counts of yarn, will be found useful to both student and manufacturer alike.

In fact, this volume is a good, sound text-book and is recommended to those requiring a thorough knowledge of the simpler weaves and of the yarns necessary for building up their structures.

A. M. LATHAM

Differential and Integral Calculus

By Prof. Ross R. Middlemiss. Second edition. Pp. viii + 497. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 16*s.* 6*d.*

THE first edition of this very useful book was briefly reviewed in *Nature* of July 19, 1941. In this new edition, the general plan has been retained and such modifications made in the text as experience has rendered necessary. These changes have involved the rewriting of many sections and several entire chapters. A serious attempt has been made to improve the rigour without adding to the difficulty of the text. For example, the treatment of partial derivatives has been practically recast in order to place emphasis on physical rather than purely geometrical aspects, while the chapter on multiple integrals has been revised and expanded to include spherical as well as cylindrical co-ordinates.

A commendable change in the sections devoted to the applications of the definite integral is the substitution of Duhamel's principle by simpler and, in some cases, by more valid methods. A drastic revision of the chapter on infinite series has been made, which now includes a useful theorem for estimating the comparative value of the remainder after k terms.

Finally, most of the problems in the original edition have been replaced and the total number increased. Curiously, answers are only provided to those exercises which bear odd numbers. As in the earlier edition, the text is clearly printed and excellently illustrated by many well-drawn figures.

Undoubtedly, the changes made by the author tend to improve the book, and no reader should have any difficulty in gaining a thorough understanding of the fundamental principles of the calculus.

Acoustics for Architects

By Dr. E. G. Richardson. Pp. 90. (London: Edward Arnold and Co., 1946.) 5*s.* net.

AS the title implies, this small book is specially written for the 'general practitioner' in architecture, who merely requires, according to the author, a statement of the fundamental acoustic principles, and help in applying them in practice. It is not intended for the physicist, who would, of course, find it far from satisfying.

In the first chapter, the author gives just sufficient information concerning the characteristics of sound to enable him to make the rest of the book fully intelligible to the reader, and he does this very well. Further, he emphasizes the importance to the architect of securing uniform acoustic conditions in a hall over the important range of frequency which lies between 100 and 5,000 vibrations per second.

A very useful second chapter is devoted to a historical survey of the study of the acoustics of buildings, to help the student to understand the problems which arise in applying the laws of sound to architecture. From this point the author develops his theme in a logical and clear way, and the last chapter gives a résumé of the principles of acoustics in the form of suggestions for planning various types of auditorium for the best conditions of listening.

The book, which is produced under war economy conditions, is well written, and what diagrams are included are straightforward and understandable.

Vie et transmutations des atomes

Par Jean Thibaud. (Sciences d'aujourd'hui.) Deuxième édition revisée. Pp. 290+24 plates. (Paris: Albin Michel, 1942.) 86 francs.

SINCE 1942, when this revised edition of an older book of 1937 appeared, relatively little has been published on nuclear physics, except in connexion with fission. This exceedingly lucid account of the subject, which has been received recently, probably remains one of the best of the few available texts of its kind. Emphasis is primarily on the experimental side, but the references to nuclear theory, and to fundamental matters of a more general character, are apt and suggestive. The plates constitute a most attractive feature. There are twenty-four of them, each beautifully printed on a separate page. A number are copied from other publications, but some appear to be original. Altogether they provide, among other things, a vivid record of the appearance of a nuclear physics laboratory and of the apparatus used in it, which is possibly of more than passing interest.

THE MAKING OF THE MISSING CHEMICAL ELEMENTS*

By PROF. F. A. PANETH

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ALMOST five years ago, in a lecture to the Institute of Chemistry in London, the success that radioactive methods had achieved in the task of completing the Periodic System was described[1]. In the table given, the place of element 87 was filled by the symbol of a newly discovered branch product in the actinium series; but in the places of elements 43, 61, 85 and 93 no symbols were inserted, although, as explained in some detail, atoms of all these four elements had been artificially produced.

This denial of full citizenship to artificial elements seemed justified in those days. They had been produced in invisible amounts only, and they were unstable and usually not present on the earth; whereas in the case of all the natural elements, we could be sure that, even if they belonged to the radioactive families and were only represented by fairly short-lived isotopes, very considerable quantities always existed. (For example, the laws of radioactive equilibrium ensure the presence in the upper 60 km. of the earth's crust of more than 10,000 tons of polonium.) The limited importance attributed until a few years ago to the artificially produced elements was reflected also by the absence of any names suggested for them.

To-day the situation is very different. In the 1942 lecture the cyclotron was called "the most efficient instrument for atomic transmutation". Now this title goes to the uranium pile, with its largely superior output of neutrons. With its help many pounds of an artificial element with atomic number 94 have been produced which, on account of its half-life of more than 20,000 years, will be present on the earth for a long time to come. (For theoretical reasons we must expect a minute proportion of element 94 always to accompany natural uranium.) Although its manufacture was difficult, it would be a harder problem still to destroy the element; even if exploded as a bomb, only a fraction of the material comes to a premature end. Moreover, the availability of any desired quantity of element 94 opens the way to the production of visible amounts of elements still higher in the Periodic System. Finally, the uranium pile has given us the means of creating lighter elements in bulk too; among the very products of uranium fission are many new isotopes not only of well-known elements, but also of the missing elements 43 and 61, which can thus be obtained in a far greater quantity than by any previous method. The chemistry of some of the newly created elements is already known as well as, or better than, that of some of the less important ones which were discovered in Nature many decades ago, and their practical application is at least a possibility.

In these circumstances, there seems to be no doubt that the time has come for the systematizing chemist no longer to discriminate between natural and artificial elements, but to pay equal attention to the study of both and, in the tables of the Periodic System, to insert everywhere the appropriate symbols. In this latter attempt we are, however, confronted with the difficulty that there is at the moment no complete agreement about the relative merits of the various claims to the discovery, or manufacture, of new elements. It is to be hoped that this question will be carefully discussed at some future meeting of a committee invested with international authority; pending that, I can give merely my personal views. However, an exchange of letters with several scientific workers interested in these questions has convinced me that most of them have come to the same, or very similar, conclusions.

In accepting names and symbols for the elements 43, 61, 85, 87, 93, 94, 95 and 96, I think chemists ought to be guided by the following rules. (1) The right to name an element should go to the first to give definite proof of the existence of one of its isotopes. (2) In deciding the priority of the discovery, there should be no discrimination between naturally occurring and artificially produced isotopes. (3) If a claim to such a discovery has been accepted in the past, but is refuted by later research, the name given should be deleted and replaced by one chosen by the real discoverer.

To state the last rule in so many words would seem unnecessary, if it were not that in at least two cases the general practice violates it[2]. The names 'masurium' and 'illinium' are so firmly rooted in text-books and tables that recent work on artificial isotopes of the elements 43 and 61 is sometimes referred to as the production of species of masurium and illinium, while the artificial isotopes actually were the first representatives of the hitherto missing chemical elements. Without going into details of the alleged discoveries, it seems necessary to say that the slowness of chemists in taking the obvious action of abandoning the suggested names is due to the failure of the claimants to withdraw their statements, although during years of intensive effort they had been unable to substantiate them. In the case of masurium, W. Noddack even went so far, five years after the announcement of the discovery, as to complain to the convener of a chemical meeting in Königsberg for not having invited him to speak on this element, as the geographical neighbourhood of Masuren would have made this specially appropriate and he would have been in a position to disclose the whole chemistry of masurium; but no communication has ever appeared on this work. During the War, W. Noddack was appointed professor of inorganic chemistry in Strasbourg by the occupying power; when in 1945 the French chemists returned, they found the symbol Ma painted on the wall of the main chemistry lecture theatre in a large representation of the Periodic System. (Private communication from Dr. J. Guéron.)

Actually, element 43 was first produced by Perrier and Segrè in 1937 by bombarding in the cyclotron element 42, molybdenum, with deuterons or with neutrons[3]. This work was extended by Seaborg and Segrè[4]. Further details may be found in my lecture of 1942[1]. As to element 61, I mentioned in that lecture the work of two research teams, Law, Kurbatov, Pool and Quill at Ohio State University[5], and Wu

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[*] Substance of a lecture delivered before the Royal Institute of Chemistry in Leeds on October 29, 1946.

and Segrè at the University of California[6]. It is most probable that both had isotopes of element 61 under investigation; but the difficulties of ascribing the various, not very strong, activities to definite atomic species were very great in those days, when cyclotron bombardment was the only means of producing them.

Now we are able to direct attention to an investigation on element 61 during the War by research workers engaged in the study of the radioactive fission products of the uranium pile. Speaking last April on the occasion of a symposium on nuclear chemistry at Atlantic City (New Jersey), Prof. Charles D. Coryell, of the Massachusetts Institute of Technology, then at the Clinton Laboratories, Oak Ridge, Tennessee, revealed that among the many scientifically important results obtained by workers on the project—he mentioned in this connexion especially N. E. Ballou, L. E. Glendenin, J. A. Marinsky, E. R. Tompkins and G. W. Parker—was the clear identification of an isotope of element 61, with a half-life of 3·7 years. It is formed by the β-disintegration of a neodymium isotope with half-life of 11 days, and decays into a stable samarium isotope. It is only a question of time when milligrams of this element, unknown in Nature, will be available for study.

The next of the missing elements, 85, was manufactured by Corson, Mackenzie and Segrè in 1940, and its chemical character studied[7]. The great significance of this work has been emphasized before[1]. We have to add now the interesting fact that about two years later Karlik and Bernert[8], in the Vienna Institute for Radium Research, obtained strong evidence that in all three natural radioactive series, isotopes of element 85 occur; they discovered new groups of α-rays, the energies of which agree very well with those to be expected for atoms of element 85 with mass numbers 218, 216 and 215; such isotopes could be formed in the radium, thorium and actinium series in the percentages observed, if either the *A*-members or the emanations showed a small tendency to β-disintegration in addition to their well-known α-decay. The experiments do not yet allow us to distinguish between these possibilities; whereas, therefore, the mechanism of the formation of these new branch products is still uncertain, there seems no doubt that the Misses Karlik and Bernert have to be credited with the proof of the existence of natural isotopes of element 85. Former claims were open to grave objections and were experimentally disproved by very careful work by the Vienna physicists[9].

Nothing new can be said about the undisputed discovery, reported earlier[1], of element 87 in the form of a natural isotope, actinium K, by Mlle. Perey[10].

The most spectacular development has taken place in the region of the trans-uranium elements. As is well known, this work had a direct bearing on the production of one type of atomic bomb and was secret during the War; but to-day a sufficient amount of information has been released to permit an appreciation of the scientific value of the new discoveries[11].

If a neutron is captured by a uranium atom $^{238}_{92}$U, a new uranium isotope $^{239}_{92}$U is formed which emits β-rays and changes, with a half-life of 23 min., into an element with a β-activity of half-life 2·3 days. The fact that this β-radiation, which had been observed before, belonged to the element 93 was proved by McMillan and Abelson[12] early in 1940 with the help of chemical and physical experiments; they are, therefore, to be considered as the discoverers of the first trans-uranium element. As its name they proposed neptunium (Np), from Neptune, the first trans-Uranus planet. Owing to its short life-time, invisible quantities only of $^{239}_{93}$Np are available. Later, however, A. C. Wahl and G. T. Seaborg found another isotope of neptunium, of mass number 237, which is an α-emitter with a half-life of 2·25 × 10^6 years; it is formed by the β-decay of a uranium isotope 237 (half-life 7 days), a substance which can be produced by bombarding $^{238}_{92}$U with fast neutrons either in the cyclotron or, better, in the uranium pile. Of this long-lived neptunium species, hundreds of milligrams have already been obtained in the form of pure chemical compounds. A thorough investigation showed that the chemistry of neptunium closely resembles that of uranium; it can occur in the same valency states III, IV, V and VI, of which the lower ones are, however, more stable than the corresponding ones in uranium.

It has already been mentioned that $^{239}_{93}$Np emits β-rays. Consequently, the daughter element occupies place 94 in the Periodic Table; its half-life is about 2·4 × 10^4 years, and it decays with α-radiation, thus being the parent of $^{235}_{92}$U, the well-known actino-uranium which forms 0·7 per cent of the naturally occurring element uranium. This isotope of element 94 was found by J. W. Kennedy, G. T. Seaborg, E. Segrè and A. C. Wahl[13] early in 1941; it was, however, not the first discovered; already in the preceding year G. T. Seaborg, E. M. McMillan, A. C. Wahl and J. W. Kennedy[14] had shown that deuteron bombardment of uranium 238 led to an isotope of neptunium of the same mass number, which is β-radiating, and thus gives rise to an isotope of element 94 with the mass number 238. This new substance emits α-rays and has a half-life of about fifty years; its disintegration product is identical with the uranium II of the natural series. Following the tradition of the naming of uranium and neptunium, the discoverers of element 94 suggested for it the name plutonium (Pu), after Pluto, the tiny outermost member of the solar family, found in 1930. The study of the properties of plutonium was at the outset very difficult owing to the invisibility of the quantities available of $^{238}_{94}$Pu; but of $^{239}_{94}$Pu, with its long life-time, one could prepare by extended cyclotron bombardment an amount sufficient for chemical investigation, albeit at the beginning only for 'ultra-microchemical' studies. Later, by the use of the neutron-capture reaction in the uranium pile, very large quantities of plutonium have been manufactured for military purposes. Its chemistry, electro-chemistry, and physical properties are very accurately known. It has been disclosed that this element, like neptunium, resembles uranium; again, we find the valencies III, IV, V and VI, valency III being more stable than in the case either of neptunium or uranium.

Since any desired amount of plutonium is now available in the laboratories engaged in the working up of the material of the uranium piles, it was only natural to try whether elements higher still in the Periodic Table could be obtained by bombarding plutonium in the cyclotron. G. T. Seaborg, R. A. James, L. O. Morgan and A. Ghiorso, in collaboration with J. G. Hamilton and his group of physicists, found that helium ions of very high energy (40 MeV.) actually produced isotopes of elements 95 and 96; not much has yet been published about their chemistry; but it seems that the general similarity of the trans-uranium group with uranium is maintained. This is no surprise if we remember that Bohr, so early as 1922, in his theoretical treatment of the Periodic System, predicted a kind of 'rare earths group' in this part of the table, beginning at, or shortly after, uranium[15]. Following this analogy, the discoverers of elements 95 and 96 propose the names 'americium' (Am) and 'curium' (Cm), to emphasize the probable similarity of their electronic structure with their lower homologues europium and gadolinium. (Obviously there were no names of further planets available; should such ever be discovered in the future, a leading American astronomer believes that his colleagues would follow then the chemical nomenclature[16].)

I hope I have made it clear that, in my opinion, if we observe the rules laid down above, there is scarcely room for any doubt as to who should be entitled to name the eight newly discovered chemical elements. For the elements 94–96 the question seems already settled, and the names neptunium, plutonium, americium and curium will most likely be generally accepted. As to element 87, a few more words are necessary. The name actinium K, as chosen by Mlle. Perey, is obviously only suitable for the particular isotope she discovered; the element, which may comprise various isotopes, should have a name not so closely linked with the special branch product of the actinium series. (Compare the sense in which 'polonium', which subsumes all the isotopes of element 84, is distinct from 'radium F', which is only the most important of the isotopes, and the first discovered.) As a result of correspondence with Mlle. Perey, I can state that she shares this view and proposes as the name for element 85 'francium' (symbol Fr).

So far no names for elements 43, 61 and 85 have officially been put forward by their discoverers, Perrier and Segrè, Coryell and his group, and Corson, Mackenzie and Segrè, respectively. Every chemist concerned with the task of teaching systematic inorganic chemistry and of keeping his table of the Periodic System up to date will be grateful if they will publish soon the names which they consider suitable. [See p. 24 of this issue of *Nature*.]

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[1] *Nature*, **149**, 565 (1942).

[2] Similar mistakes have been perpetuated in the older nomenclature. For example, the last of the rare earths should not be called lutetium (Lu), but cassiopeium (Cp); about the priority of Auer v. Welsbach's claim see F. A. Paneth, *Ergeb. exak. Naturwiss.*, **2**, 168 (1923).

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[7] Corson, D. R., Mackenzie, K. R., and Segrè, E., *Phys. Rev.*, **58**, 672 (1940).

[8] Karlik, B., and Bernert, T., *Z. Phys.*, **123**, 51 (1944).

[9] Karlik, B., and Bernert, T., *Naturwiss.*, **30**, 685 (1942); *Sitz. Wien. Acad.*, **151**, 255 (1942).

[10] Perey, M., *J. Phys. et le Radium*, **10**, 435 (1939).

[11] See especially G. T. Seaborg, *Chem. and Engin. News Edit.*, **24**, 1192 (1946).

[12] McMillan, E. M., and Abelson, P. H., *Phys. Rev.*, **57**, 1185 (1940).

[13] Kennedy, J. W., Seaborg, G. T., Segrè, E., and Wahl, A. C., *Phys. Rev.*, **70**, 555 (1946).

[14] Seaborg, G. T., McMillan, E. M., Wahl, A. C., and Kennedy, J. W., *Phys. Rev.*, **69**, 366 (1946).

[15] Bohr, N., "Spektren und Atombau" (Vieweg, 1922), 133.

[16] Shapley, H., in "One World or None" (McGraw-Hill Book Co., 1946), 10.

POPULATION STUDIES IN FISHERIES BIOLOGY

By G. L. KESTEVEN

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THE analysis of populations of fish, chiefly in relation to age composition, has developed greatly since Peterson[1] described his method of dissecting length–frequency curves. Such analysis makes use of the ability to identify the age of fish from certain structural features of scales, otoliths and similar structures, and is associated with the problem of measuring the rate of growth. For effective application, this work requires the employment of vigorous sampling techniques related to commercial and experimental operations, as described by Fridrickson[2], Hodgson[3] and Sette[4,5]. Analyses of this kind have been employed for the following purposes: (*a*) to compare stocks of different regions[6]; (*b*) to compare stocks at different times[7]; (*c*) to assess mortality-rates[8]. The first two have been employed chiefly in relation to the study of 'condition' of fisheries in connexion with the possibility of depletion. The latter use was developed by H. Thompson[8] when, in working on haddock, he presented a technique for measuring recruitment into the fishable stock and for subsequent assessment of the effect upon the stocks of the strength of successive broods.

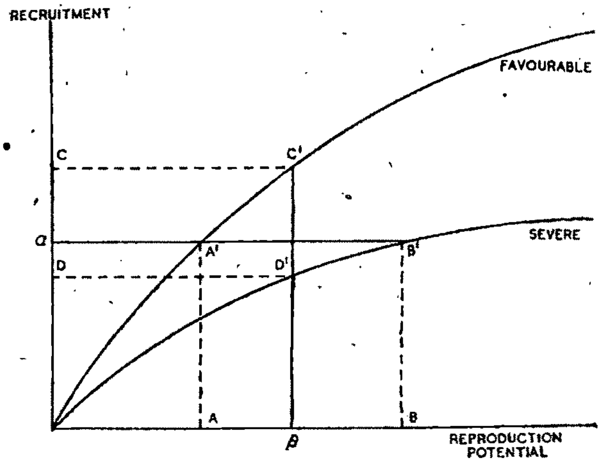
It does not appear to have been appreciated that the analysis of the stock can have greater meaning than hitherto has been seen in it. Its value is not so much for the primary result of revealing the relative numbers of various size, age, sex, gonad condition, feeding and other biological groups which characterize the population, nor even for the indication which it might yield of the possibility of depletion: its chief significance is as a means of measuring the dynamic properties of the population, interaction of which with the environment determines the compositional characteristics. The main properties are the potentials of growth (weight increase) and reproduction, and despite the work of Chapman[9] in presenting the original concepts in this work, the significance of these potentials has been neglected.

It has been argued[10] that no necessary relationship exists between the number of spawners of a particular stock in a particular year and the number of young fish eventually recruited to the fishery. There exists here some ground for misunderstanding: the vicissitudes to be suffered by spawners, eggs, larvæ, post-larvæ and young fish are such that the argument as to numerical relationship between any pair of the above links in the reproductive chain has little or no validity as between any other pair; yet this does not make it impossible to measure the successive relationships, in conjunction with observations upon the environment. The necessary analysis of these components has begun already in the work on plaice[11] and haddock[12], in which the strength of the spawning population has been estimated from egg abundance, and the dispersal and mortality of eggs have been measured. Further work on haddock[13] has attempted analysis of the relationship between strength of the mature population and survival of broods. The technical difficulties of this type of work, particularly in planktology, are not belittled; but it is held that they have already been shown to be not insuperable.

It is suggested that a first purpose of stock analysis is to yield a preliminary estimate of the likely abundance of eggs to be produced by the population, that is, the potential fecundity of the spawning population. From that point observational work should provide an estimate of the *effective* egg production, and eventually of the survival of eggs, larvæ and young fish. Theoretically the sequence should thus lead to an estimate of recruitment, the accuracy of which could be compared with the observed strength of the recruit class. Continuance of such work over a number of years would undoubtedly yield a fairly precise correlation between the three elements : (*a*) the spawning population ; (*b*) environmental conditions ; (*c*) recruitment. With refinement of technique and extension of sampling, such work should convert the preliminary relative estimates of (*a*) and (*c*) into reliably absolute ones, and after sufficient years the actual strength of each age (or other) group will be known from having been observed since its spawning. A schematic representation of these relationships is given in the accompanying illustration. The fact that the actual relationship between reproduction potential and recruitment might be quite other than the curvilinear one shown here does not detract from the generality of the argument presented. It is suggested that for any level of reproduction potential, say, on the ordinate, there exists a range of levels of recruitment between C and D on the abscissa marked off by the projection from the points C' and D' on the curves of relationship which delimit extremely favourable and extremely unfavourable environmental conditions. Such limits as these could be marked off in a scatter diagram; but it is recognized that the accumulation of sufficient material for this method would be a matter of considerable difficulty, and it is suggested as alternative that quantitative expression of environmental favourability should be attempted and the limits suggested in the illustration defined thereby. On the other hand, the relative position on a diagram such as this of point relationships between estimated reproduction potential and observed recruitment should indicate relative favourability of the environment and assist in assessing the significance of various environmental factors.

The significance of these suggestions in the general theory of fisheries exploitation is discussed below.

Growth curves measuring linear and mass increases have been prepared for very many species of fish. Since it is possible to measure the amount of growth which a fish of a given age is capable of accomplishing in a given period, it should also be possible to predict the amount of growth which numbers of fish of diverse ages should be able to accomplish in a similar period. Such growth would, of course, be dependent upon the amount of food available relative to the requirements of the population, and upon other environmental factors. Some experimental research has been carried out on the nutritional requirements of fish[14]; but it is not surprising, remembering the difficulties of experimenting with fish, that this work has not yet got very far. The observational work on conditions of growth of fish is also inadequate, particularly in connexion with the effect of population densities upon growth. There has been much controversy, for example, over the question of whether over-crowding reduces the growth-rate, and whether the converse, depopulation, is likely to lead to increase. However, observation of stock composition, estimates of related growth potential, and subsequent measurement of growth achieved should permit a correlation between growth potential and the environment, similar to that proposed between reproductive potential and the environment, and allow a useful prediction of the amount of increase in mass which may be expected from the population.



THEORETICAL RELATIONSHIP BETWEEN RECRUITMENT AND REPRODUCTION POTENTIAL

As offset to the increase in numbers (reproduction) and in mass (growth), natural and fishing mortalities operate to reduce the population. Many mathematical analyses have been made[15] of the relationships between hypothetical values of the terms fishing mortality, natural mortality, growth and reproduction; but it has yet to happen that anyone should prepare a formula which has validity over a wider range of years than that for which the formula was prepared. The formulæ so far presented to describe fish populations relate chiefly to the consequences of changes in the intensity of fishing operations. It is not, I believe, unfair to say that none of them has attempted to evaluate the actual properties of any fish population (even theoretically), or to conceive the measurement of the interaction of population and environmental properties, with the view of determining the basic reasons for mean levels of abundance and year-to-year changes of these levels. In point of fact, it has been a matter of some concern that the relationship between the fisheries biologist on one hand and the hydrological and planktological team on the other has at most times been somewhat tenuous. The results of the work of the latter group have been applied in biological analysis in a somewhat haphazard fashion : the boundaries of major water masses have been recognized and correlated with certain biological phenomena[16,17], and some correlations between occurrences of fish and wind[18] and phytoplankton[19] have been demonstrated; but these fall far short of the degree of integration which must be achieved to bring this science to the level of precision of which it is capable.

Of the formulations of the modern theory of fishing, Russel's[20] is probably simplest. According to this

$$S_2 = S_1 + (A + G) - (C + M),$$

where S_1 and S_2 represent the stock in successive years, A the recruitment, G growth, A and M catch and mortality. It will be recognized that this constitutes a useful symbolism, facilitating discussion, but is not an analytical weapon. Subsequent formulations have been presented by Graham[21], Thompson and Bell[22] and Thompson[23], and these have some continuity with the work of Baranov[24,25]. These theories have been mainly concerned with the effect of fishing upon the stocks, and have approached the matter by way of attempted theoretical equations for the gross elements of the system ; they have been based upon the recognition of a stock of fish as a self-reproductive system, the growth of which is demonstrably a simple exponential function. However, it has been necessary to assume values for the various elements, and by test to ascertain which combination of rates best fitted the observed conditions. Moreover, this work has been concerned with the population as a whole, and reproduction-rates, etc., employed have been assumed sum expressed rates for the population : that is to say, the technique presents a theoretical description of the population, but no analysis. One consequence of this approach to the population as an implied homogeneous whole has been a fallacy in respect of the significance of the point of inflexion of the sigmoid curve describing the growth of the population. Graham[26] has argued that since the rate of growth in an organism, or population, is greatest at the point of inflexion of the sigmoid curve which describes that growth, then the rate of growth at this point represents the optimum which may be expected from each population, and the catch which can be taken from a fish population at that point will prove to be the optimum. It is pointed out, however, that at the point of inflexion the high rate of growth represents the highest excess of reproduction over mortality (that is, of individuals of which the population under consideration is composed, whether cells or organisms) ; but actually reproduction will be greatest at some later point. Since a post-reproductive group has not yet been demonstrated in fish, it is presumed that both reproduction and mortality will continue to mount higher with the increase in the size of population, provided such numerical increase in population strength is not solely composed of young fish, with consequent decline in average age for the population.

The relationship between recruitment, mortality and intensity of fishing has lately been submitted to more detailed mathematical analysis, especially by Ricker[27,28].

It is the intention of this paper to submit that the approach to this problem has hitherto been insufficiently balanced. Raitt[29] has referred to the intricacy of the relationships involved in relation to reproductive capacity, and the work of Baranov[24] and Herrington[13] has considered the problems of nutritional limitations upon population growth. But these fill in detail of only part of the picture of a few populations. What is required is the comprehensively detailed analysis of the population to identify all the components of the system, and to measure the factors which operate upon these components. This will yield a better measure of the consequences of fishing, both the immediate effect of proportional removal and the later consequences to population properties of these removals. Further, this work will permit a more realistic approach than has hitherto been possible to the question of determining optimum catch ; that catch being defined as the quantity, from each particular population, which will ensure the fullest expression of the population's potentials of growth and reproduction. Definition in this form is necessary since the precise relation between the various terms is as yet unknown. I have recently[30] given a general discussion of the planning of this work.

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RECENT ADVANCES IN CANCER RESEARCH*

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EXPERIMENTAL cancer research is less than fifty years old, even younger than bacteriology ; a few of those who began it are still active. It started when the rewards of the close observational study of human cancer had become small. Then for the first time medical scientists paid attention to the fact that animals have tumours too—a fact known for some while. With the demonstration that these growths are true neoplasms (new growths) and the transfer of some of them from host to host, things got under way. At first hopes ran high that the cause of cancer would soon be found ; but then it became clear that the animal tumours maintained by transplantation carried the secret along with them. Nothing could be procured from the tumour cells which would cause other growths, and anything killing them, in even the most subtle way, brought the neoplastic process to an end. Furthermore, the transplanted tumours called forth no resistance of practical significance. The cultivation of cancer cells *in vitro*, though occupying many workers, contributed no deep-going enlightenment, and until 1915, when tumours were purposely induced by means of tar, workers were unable to get at the conditions determining the occurrence of neoplasms. Until then observations on the 'precancerous states' of man had been the sole reliance of the investigator, since the spontaneous growths of animals had progressed too far when first encountered to be informing. Now at last the conditions leading to cancer could be got at experimentally.

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This paper is concerned with recent advances. Perhaps the biggest step forward of the last few years has been the comprehension, gained very gradually during the busy production of tumours by experimental means, that cancer is not a separate neoplastic entity, standing by itself, but merely one among the immense group of the true neoplasms, all these exemplifying the same general principles however much they differ in cellular composition. Every worker knows that carcinogens call forth growths of all the main categories dealt with in the text-books on human neoplasms. A single chemical carcinogen may elicit the entire gamut of the tumours, the precise kinds which occur in any experiment depending upon the kinds of cells on which the agent is brought to bear; and the most widely different carcinogens may give rise to tumours of identical sort. Not only this, but they also call forth the leukæmias as well, and almost insensibly these latter have come to be acknowledged as within the neoplastic fold. Every now and then, indeed, leukæmias are met with or induced in animals, which are made up of cells capable of giving rise to local tumours if injected into the connective tissue instead of into the blood. The investigator who tackles the cancer problem really tackles the tumour problem as a whole, and he can hope that by studying one growth he may learn something about them all. From here on the words 'cancer' and 'tumour' will often be used interchangeably.

Long before the first tumour was induced in an animal, physicians were well aware that there are agents in the human environment which are capable of giving rise to neoplasms. But nobody had any conception of how many there are, or can be in the future—for chemists are now synthesizing new ones. Now we know them in bewildering variety, and must expect to encounter them more and more in the future as new physical and chemical processes of unplumbed capabilities are pressed into industrial service. We literally spend our lives among them—the very sunlight is carcinogenic—and the only reason any of us go free from cancer is because the action of most carcinogens (for that is still the word used) is episodic or weak. Two British workers, Prof. E. L. and Mrs. Kennaway, have lately found, on scrutinizing English statistics, that cancers of the skin, mouth, throat, œsophagus, and stomach, all the way to the pylorus, are more frequent the lower one looks down the social scale. Evidently the skin of poor people is more likely to be injured in ways that may bring on cancer than that of those who are rich, and perhaps what they eat and drink is more likely to contain carcinogens.

A far more difficult problem than the environmental carcinogens—since these can be warded off in proportion as we get to know them—is that of carcinogenic agents arising within the body. There are strong reasons for supposing that often they do so. Some years ago the fact was brought out that tar produced by the heating of human skin would give rise to cancers when painted on the backs of mice. Of course, this did not justify the conclusion that human skin elaborates tar: one might almost as easily suppose that because the body contains hydrogen, oxygen, and nitrogen, it produces fuming nitric acid. In the last few years the discovery has been made that extracts of some diseased human tissues are capable of producing tumours in animals. It might be argued that the chemical procedures employed in obtaining the extracts have resulted in the production of substances not existing under natural conditions. But control extracts made in the same way from the normal tissues seldom have a carcinogenic action. As already stated, it is not the presence of a carcinogen, but its presence in effective quantity, which determines whether a tumour will arise. The subject of endogenous carcinogens (substances formed within the organism and capable of producing tumours) is one of the pressing themes of the present day.

For some while it has been known that certain normal substances, namely, hormones, may give rise to tumours. These substances are not themselves carcinogenic, they do not themselves cause normal cells to be tumour cells, but they bring the tissues they act upon into such a disordered and excited state that neoplastic changes take place for reasons unknown. Nobody knows what kinds of tumours they may not give rise to next in animals if administered in sufficient amount, and the present uncertainty in this matter deserves stress because the œstrogens are the best studied of the hormones. A vast amount of new knowledge in relation to cancer waits upon further tests of this class of substances.

The more closely one looks into how 'spontaneous' tumours, so called, come into existence, the more clearly does one perceive that often they are the outcome of many influences and circumstances working together or consecutively, often through years. Even the smallest details in the previous history of cancer patients may prove vital for other human beings, as giving hints as to where the chain of determining factors can be broken which leads on to the disease. Too much pains cannot be spent in eliciting such case-histories. My own belief is that eventually there will be specialists in every cancer hospital whose main aim and ambition will be to learn precisely how each patient's tumour has come about.

For nearly seventy-five years medical men have been aware that cancers often arise at sites of chronic disturbance, yet mere chronic inflammation is not enough of itself to cause them. Some special influence there is which precipitates the neoplastic change. Some workers, notably Prof. A. Haddow, have concluded that the cells become neoplastic while they are faring badly, and that the chemical carcinogens act through the depression of cellular activities that they bring about. Certain it is that injection of some of these substances causes transplanted tumours to grow more slowly than in control animals. Just before the War, a German surgeon, led on by this finding, actually painted human cancers of the skin with a powerful carcinogenic hydrocarbon, heedless of whether it induced other growths later on. He reported that the tumours disappeared, and we will doubtless never know what happened later. Haddow himself has synthesized numerous hydrocarbons nearly related chemically to those of carcinogenic sort, in an effort to find some which would check established tumours while giving rise to none on their own account. His results in animals are encouraging to further work, and he has now begun to make clinical trials on inoperable cases. Laboratory observations made in the United States during the War on the effects of the 'nitrogen mustards' in retarding cell activity have led to the treatment with them of lymphoid tumours and leukæmia in human beings. There cannot be too many well-reasoned efforts such as these.

What can the cause of tumours be, the actuating cause which keeps cells in the neoplastic state ? One favourite idea was abandoned during the first years of experimentation with carcinogenic agents; the idea that cells run amuck, forming tumours because of a relaxation of some governing influence of the body which had kept them in order previously and doing what they should. The fact that tumour cells are no mere ordinary cells which have seized an opportunity to develop in a haphazard fashion is the basis for the present-day search for some distinguishing chemical trait of the neoplastic cell. Already remarkable differences have been discovered, and some day one that is crucial may be found.

All medical men realize that most of the agents which are highly effective in producing tumours, the roentgen ray and Bilharzia ova for example, cannot possibly be the real causes for these growths. Their part is played when they have produced neoplastic change; the tumour goes on just as a fire goes on which has been kindled in any one of a myriad ways. The fact that certain hydrocarbons have been found capable of inducing tumours has led workers to ask whether substances having similar effects may not be continually elaborated within neoplastic cells and maintain them in their pathological state. Even if this is not the case, a knowledge of precisely what the synthetic carcinogens do to cells may prove broadly enlightening. Chemists are concerning themselves with these possibilities, trying to learn precisely what radical, or bond, or configuration of the carcinogenic molecule is associated with its singular effect.

New opportunities have lately been provided for studies on tumour causation through a feat of the geneticists. Strains of animals have been procured with striking liabilities to spontaneous tumours of one sort or another and equally remarkable freedoms from such growths. A high percentage of the animals of certain breeds, in some instances every animal, may develop lung tumours or liver tumours or leukæmia after they grow up, or every ageing female may have mammary cancer ; while other strains almost or never have growths of the sorts mentioned. And behind the primary tumour liabilities there may be secondary ones ; an animal escaping the mammary tumour which kills most individuals of its strain may be prone to leukæmia later on.

What are the reasons for this state of affairs ? At first it was assumed that the tumour tendencies are passed on through the chromosomes, that they are hereditary ; and then workers in Holland and at Bar Harbor in Maine, studying hybrids between mice of strains having marked and slight liabilities respectively to mammary cancer, simultaneously found that the tendency to such tumours is handed down through the mother. There followed a startling discovery by Dr. J. J. Bittner, one of the Bar Harbor group. He took new-born mice away from mother mice of strains liable to mammary cancer, had them suckled by females devoid of this liability, and found that thus he had rescued them from having the disease in later life. Also, by carrying out the experiment in the opposite direction, the tendency to mammary cancer could be conferred upon mice of strains not having it ordinarily. In mice with the tendency to mammary cancer something is passed along from one generation to the next in the mother's milk—the 'milk factor' as it is now called. A single suckling after birth is enough to confer the tendency to cancer on not only the young nursing animal itself but also its descendants as well. *Per contra*, whole races of mice can be rescued from having mammary cancer by preventing the passage of the milk factor to the individuals from which they have descended.

The milk factor does not produce its effect at once. It reaches the mammary tissue from the gut, increasing in quantity as the glands develop, and one adenocarcinoma or several make their appearance in the breasts of the mice as they grow old, sometimes in every animal. Yet nothing can be obtained from the mammary tissue or from the cancers which will cause such growths directly on injection into other individuals, only the milk factor, though this in great amount. One-millionth of a gram of mammary tissue yields enough of it, on extraction, to confer the tendency to mammary cancer on an endless series of animals. A great deal has now been found out about the factor, and everything puts it in the category of the viruses save the fact that it does not induce disease directly. The most reasonable explanation for the way it works is that it is a harmless virus, flourishing and increasing in the mammary tissue, and liable to vary so that it becomes a tumour-producing virus when its cellular environment undergoes pathological alteration, as in the breast of mice which have grown old.

One cannot doubt that within the human species there are hidden liabilities to tumours which find individual expression now and again ; but statistics show that only very rarely is the layman's fear justified that there is 'cancer in the family'. Perhaps on the analogy of the inbred, pure-strain mice, brother and sister matings of human beings during a thousand years might result in pronounced familial differences as concerns the incidence of cancer ; but as matters stand we can be thankful that we are a mixed lot. Certain workers with the milk factor have lately urged that the babies of human families in which mammary cancer has occurred should be raised on the bottle ; but this is to subject the child to very real dangers because of fears which are ill-grounded, as the statistical evidence demonstrates.

The existence of the milk factor has given new support to the hypothesis that tumours in general may be due to viruses. Despite many attempts during the last thirty years, no viruses directly causing neoplasms have been obtained from rat or mouse tumours—the common currency of the laboratory—though a few out-of-the-way growths have yielded them. The great majority of workers on the cancer problem see little in the idea that most tumours are due to viruses, and recent experimental evidence speaks against the assumption that agents of this sort, passed from one animal to another, can be their cause. But decisive evidence in the matter may soon be available, for much can be expected of the new techniques for visibility now being worked out. With the electron microscope, Drs. A. Claude and K. R. Porter have already been able to obtain pictures of chicken tumour viruses within the cells of the sarcomas that they cause. Caspersson in Sweden is photographing cells of many sorts with ultra-violet light of special wave-lengths, and he has thus disclosed much that was not known concerning them.

It might be thought that we would now be possessed of a thorough knowledge of what tumours themselves are like through the diligent observations on human growths made during the last hundred years; but the very conception of what a tumour is has been proved far off the mark by a recent discovery. The long-accepted definition has been that a tumour is an autonomous new growth. But Prof. C. B. Huggin's demonstration that many prostatic cancers which have metastasized stand still or disappear after removal of the patients' testicles shows that even the cells of malignant growths, of cancers ordinarily fatal, may not be truly independent in their behaviour. The cells of these prostatic cancers have been spurred on by the male sex hormones elaborated within the testicles and responsible for the normal activities of the prostatic epithelium. When not thus urged they in some instances are unable to grow, and in others are incapable even of maintaining themselves.

The meaning of this discovery far transcends its practical application; for it means that thought and endeavour in cancer research have been led astray by the idea that tumour cells are anarchic. Medical scientists have long been aware that even the worst cancers nearly all make some attempt at the customary tasks of the body. But no one had shown that neoplastic cells making such attempts at function might also respond in line of duty to normal physiological influences such as the hormones exert. How far this principle finds expression in tumour behaviour has yet to be learnt, and how successfully it can be utilized in combating tumours. The course of events with prostatic cancer justified the expectation that many mammary cancers would regress when the influence of the female sex hormone was lessened by removal of the ovaries or by injections of testosterone. While the results with women have not been very promising thus far, the fact that cancers of the male breast yield to orchidectomy or to stilbœstrol provides encouragement, for it makes plain the existence of factors of critical importance which have still to be understood and pressed into service.

At the moment the role of the hormones in the production and behaviour of tumours occupies many of the best investigators, and scarcely a month goes by without some discovery. For example, certain transplantable testicular tumours in mice will grow only if the new hosts are given œstrogen. Lipschütz, working in Chile and following up a discovery made by Nelson, that uterine myomas appear in guinea pigs repeatedly injected with œstrogen, has now demonstrated that testosterone will prevent them from developing. Whether this has a practical bearing remains to be seen.

It is a curious fact that, while hormones play an important part in tumour production and behaviour, little has been found as yet that the vitamins do. This is not for lack of tests with them.

The dependence of some tumours on hormonal influences justifies the inference that the change of a normal cell to a tumour cell is far from meaning that a growth will arise; and direct proof on this point has for some while been available. It has been found that if the calorie intake of mice is cut down so slightly that the animals are only 5 per cent under weight, appearing fit instead of fat, carcinogenic agents induce no tumours on their skin. This is not because these agents have failed to bring about neoplastic changes; for if the animals are full-fed later, tumours start forth. The 'spontaneous' pulmonary growths to which mice of some strains are liable can also be prevented by cutting down the food. It would be worth while to know whether cancer has fallen off in the starving populations of Europe. At the moment much work is under way to learn whether modifications of the diet which involve no reduction of calories will hinder tumour growth.

But how shall the presence of hidden, incipient cancers be perceived? The hope that they may elaborate specific antigenic substances, and thus provide serological tests, goes back to the first years of immunology, and recently an antigen has been come upon; Kidd has demonstrated the existence of a distinctive antigenic substance in the Brown–Pearce rabbit carcinoma. No path has been opened as yet, though, by this discovery, for the substance has proved to be peculiar to the Brown–Pearce tumour, and serologically quite different from an antigen encountered in another kind of epidermoid carcinoma of the rabbit. On the basis of these findings one might perhaps look forward to a multitude of diagnostic blood tests, each for some tumour of special sort, but not to a single test which would help in the generality of human instances—those in which the doctor wants to know whether there is any tumour at all in his patient, its nature coming afterwards. Even the possibility of special tests is still problematic, since the production of antibodies in rabbits with the tumours just mentioned, a production necessary to serological tests, is inconstant despite the circumstance that every one of the growths themselves contains the specific antigen.

FREQUENCY-MODULATION IN BROADCASTING

FREQUENCY-MODULATION, or the technique of varying the frequency of radio waves for signalling purposes, has been known and used for many years; but it was not until Armstrong in the United States in 1936 pointed out the importance of wide-band frequency-modulation on ultra-short waves, combined with a means for noise suppression, that the practical possibilities of the system for broadcasting purposes were realized. A considerable amount of development work on frequency-modulation technique took place in the United States before the War, and a number of broadcast transmitting stations have been erected and are using the frequency band 40–50 Mc./s. (wave-lengths 6–7·5 m.). It was not possible during the War to obtain much first-hand information as to the practical results obtained in the United States; and so in view of the probable importance of the system in improving both the overall coverage and the quality of reception in broadcasting, the B.B.C. decided just before the end of the War to conduct field trials in Great Britain. A discussion of the relative merits of frequency-modulation for broadcasting purposes, and of the first results of these trials, is given in an article by H. L. Kirke in the *B.B.C. Quarterly* (vol. 1, No. 2, July 1946).

In frequency-modulation technique, the radio carrier-wave is varied in frequency by an amount depending upon the amplitude of the modulating oscillation and at the frequency of the modulation, which for sound broadcasting is within the normal audible range. At the greatest amplitude of modulation, the change in carrier frequency is termed the deviation, and the value of this as used for broadcasting in the United States and likely to be adopted in Britain is ± 75 kc./s. In contrast with this system is that of amplitude-modulation, which is used in normal broadcasting, and in which the amplitude of the carrier is varied at the modulation frequency from zero to twice its normal unmodulated value, the frequency of the carrier wave remaining unaltered during the modulation process. Any increase of modulation amplitude beyond the above maximum value would result in distortion both at the transmitter and at the receiver. In the case of frequency-modulation, there is no precisely defined point at which distortion sets in, so that if the transmitter and receiver circuits are suitably designed, a greater range of modulation can be achieved with the frequency- than with the amplitude-modulation system.

In order to render a frequency-modulated signal audible, the receiver uses a device known as a 'discriminator', which in effect converts it into an amplitude-modulated signal, which may then be detected by any of the usual methods. Since no change in amplitude of the carrier wave is required to convey intelligence, the transmitter can be operated under constant load conditions of high efficiency; and at the receiver a limiting device can be used to make it insensitive to amplitude changes, and thus limit the effects of receiver noise and electrical interference. While it would not be worth while using frequency-modulation on medium or long waves, because the band-width would have to be restricted, this does not apply to ultra-short waves, less than 10 metres in length; and the wide-band modulation can here be used to advantage with an extended audio-frequency range and improved quality of reception.

These advantages of the frequency-modulation system for broadcasting on ultra-short waves are discussed in some detail in the article referred to above, and illustrated by tabulated results and graphs applicable to frequencies of 45 Mc./s. (6·7 m.) and 90 Mc./s. (3·3 m.). For example, the electrical interference from motor-car ignition systems, which is a serious factor in the reception of ultra-short wave broadcasting, is much less serious with frequency- than with amplitude-modulation. Incidentally, in the course of experimental observations on this point made alongside a main arterial road, it was found to be extremely rare to get any interference from military vehicles, which have suitable radio-frequency suppressors fitted. The universal fitting of suppressors to motor vehicles would therefore increase the service area of a broadcasting transmitter very considerably. While the interference tests which have so far been made indicate that, on a frequency of 90 Mc./s., the field-strength required to give satisfactory reception in the presence of a given amount of interference is only about one-third that required on 45 Mc./s., it is to be noted that the field-strength obtained on the higher frequency may be less, due to greater attenuation and screening effects. The effective range is thus about the same on the two frequencies, and in both cases the use of horizontal polarization appears to be preferable.

The propagation of ultra-short waves is not greatly affected by the nature of the ground over which the waves pass, as is the case for medium and long waves; but the shorter waves are more affected by ground contour, hills casting shadows and thereby degrading the reception conditions in valleys. Considerable advantage is obtained by placing the transmitter on high ground, with as high an aerial as possible. The meteorological conditions in the atmosphere also affect the propagation of ultra-short waves, causing them to be refracted and so to reach greater distances than would otherwise be the case. The B.B.C. has carried out surveys of field-strength on both 45 and 90 Mc./s. from transmitters located at the Alexandra Palace Television Station and at its Research Department, near Oxford. Typical results described and illustrated in the paper show the effect of ground contour and the fading that is encountered when the receiving point is at or beyond direct optical range from the transmitter.

The latter portion of Mr. Kirke's article is concerned with the planning of an ultra-short wave broadcasting service, and tables are given showing the coverage area to be expected on each of the two frequencies considered, and for four grades of service between first-class reception in an urban area to second-class reception in quiet rural surroundings. Confirmation of these calculations is being obtained by the provision of practical data on the reception of frequency-modulation in the home, in the course of special tests in which members of the staff of the B.B.C. co-operate. It will thus be realized that active consideration is being given to the possibilities of ultra-short wave broadcasting with the view of relieving the present congestion in the medium and long-wave bands, and providing a satisfactory frequency-modulation service of high quality throughout Great Britain.

SCIENTIFIC CENTENARIES IN 1947

By ENGINEER-CAPTAIN EDGAR C. SMITH, O.B.E., R.N.

A REVIEW of the centenaries which occur in 1947 may well begin with a footnote to Prof. W. M. Smart's address to the Royal Astronomical Society on "John Couch Adams and the Discovery of Neptune", published in *Nature* of November 9, 1946. With the publication of the facts connected with the discovery, the controversy began to subside, and at the Oxford meeting of the British Association in June 1847, Adams and Le Verrier met. The latter had been invited to England by Airy; and J. D. Forbes recorded how he dined at Prof. Powell's with a small but excellent party including Airy, Le Verrier and Adams. Afterwards Forbes went to the Observatory to see Neptune. "Fancy the interest," he wrote, "of seeing the new planet for the first time in company with its two discoverers! Of course, there could be no going to bed without seeing it, and accordingly as it rose late, I did not get back to my college till very nearly two in the morning." A month later Le Verrier was at Cambridge, and so was Otto Struve, and Murchison wrote, "Whilst walking across the quadrangle of Trinity, Leverrier on one arm and Struve on the other, we saw the Duke of Wellington coming towards us in his red gown and I at once said to the two great astronomers, 'Now, gentlemen, here is the opportunity'. Struve was overjoyed, saying it was the thing of all others he wished; but Leverrier turned on his heel and left us saying, 'Pardonnez, c'est plus fort que moi; je suis Francais'."

That Oxford meeting was memorable for another reason, for it marked the beginning of the friendship of Joule and Prof. William Thomson, afterwards Lord Kelvin. To the Physics Section, Joule gave an account of his experiments on the mechanical equivalent of heat. His previous communications had not excited much interest, and this time the same thing might have happened had not "a young man . . . risen in the Section and by his intelligent observations created a lively interest in the new theory". The young man was Thomson, then twenty-three years old; Joule was twenty-seven. In a letter to Bottomley, Thomson said "that at first he thought Joule must be wrong but as he listened he recognised that Joule had certainly a great truth and a great discovery and a most important measurement to bring forward"; about a fortnight later, Joule and Thomson met in Switzerland, where Joule was spending his honeymoon.

Of the notable men of science born a century ago, there is no need to say much of Thomas Alva Edison, man of a thousand patents, who was born in Milan, Ohio, on February 11, 1847, and died at West Orange, New Jersey, on October 18, 1931; or of Alexander Graham Bell, who was born in Edinburgh on March 3, 1847, and died near Baddeck, Nova Scotia, on August 2, 1922. To them both could be applied the oft-quoted epitaph to Wren to be seen in the north transept of St. Paul's Cathedral. Bell's father, uncle, brothers and grandfather had taught the laws of speech in the Universities of Edinburgh, Dublin and London, and his own work was directly in line with theirs. Edison's forbears—colonists, farmers, merchants, men of exceptional physique, energetic and independent—had nothing to do with science, and in the boy's environment there was little to suggest that he would sit up all night poring over Faraday's writings, or become known as "the Wizard of Menlo Park".

In Edison's early days, telegraphy was the principal branch of electrical engineering, and it attracted many scientifically trained investigators. Among these was William Edward Ayrton, F.R.S. (1847–1908), inventor with John Perry of many electrical instruments and a promoter of technical education. He was president of the Institution of Electrical Engineers and of the Physical Society, and several times dean of the Central Technical College, London. The Russian electrician, Paul Jablochkoff (1847–94), was a telegraphist, and at the age of twenty-four was director of the telegraph between Moscow and Kursk. This post he gave up to work at electric lighting problems. His electric 'candles', patented in 1876, were shown in the East India Docks, London, in the following year, and in 1878 were used for lighting the Place de l'Opéra, Paris. Prof. Silliman of Yale was delighted with them, and wrote, "The effect is magnificent and at this moment there exists nothing in this city of splendid effects to compare with the magical scene. The vista is about two-thirds of a mile and the effect incomparably finer than any show of artificial illumination ever before seen." Alas! Jablochkoff's 'candles' had to give way to the lamps of Swan and Edison, and their inventor returned to Russia and apparently died in poverty. Electrical engineering was also furthered by the work of the distinguished engineer and educationist, Sir Alexander Blackie William Kennedy, F.R.S. (1847–1928). Kennedy started work in a Thames-side marine engineering shop; but at the age of twenty-seven was made professor of engineering in University College, London, where he founded the first laboratory for experimental work on an engineering scale. For twenty-five years he held his chair, and then he turned from civil and mechanical engineering to electrical engineering. His services were sought for many schemes, and he was president of both the Institution of Civil Engineers and the Institution of Mechanical Engineers—which body will in June fittingly commemorate the centenary of its foundation at Birmingham with George Stephenson as its first president.

At University College, Kennedy counted among his fellow professors another great London teacher, Sir Edwin Ray Lankester, F.R.S. (1847–1929), who held the chair of zoology from 1874 until 1890, and some time afterwards became director of the British Museum (Natural History). He was the son of Dr. Edwin Lankester, F.R.S. (1814–74), a physician, coroner and botanist, who at the time of his son's birth was secretary of the Ray Society, founded in 1844.

To these names of distinguished men whose centenaries fall this year may be added those of Thomas Andrews, F.R.S. (1847–1907), a Sheffield iron-master and an active investigator into the structure and properties of metals; William Denny (1847–87), of Dumbarton, the first private ship-builder to set up an experimental tank after the plans of his friend, William Froude; and James Ludovic Lindsay, twenty-sixth Earl of Crawford and ninth Earl of Balcarres (1847–1913), to whose munificent gift of astronomical instruments and books was mainly due the building of the fine Royal Observatory on Blackford Hill, Edinburgh.

The losses by death among men of science in 1847 do not appear to have been as numerous as they were in 1846, but geology and mineralogy were all the poorer by the passing of Alexandre Brongniart (1770–1847), long the associate of Cuvier. Brongniart was director of the porcelain factory at Sèvres and professor of mineralogy in the Museum of Natural History, Paris. With Cuvier he made many geological excursions into the country around Paris; after reviewing their joint labours, Geikie said that by their demonstration of the use of fossils for the determination of geological chronology, they deserve an honoured place among the founders of geology. Six months before Brongniart died, Mary Anning died, at the age of forty-seven. She was the daughter of a carpenter and vendor of natural curiosities of Lyme Regis; when a girl of only twelve, she found the fossil bones of an ichthyosaurus, and when twenty-one and twenty-seven respectively, discovered the first specimens in England of a plesiosaurus and a pterodactyl. She died on March 9, 1847, and fifteen years later the Geological Society erected a memorial window to her in the parish church of Lyme Regis. James M'Cullagh was the son of a small farmer, but he too made a name for himself. By intense application of his unusual powers, he rose to be professor of natural philosophy in Dublin and secretary of the Royal Irish Academy, his writings on the theory of light gaining for him in 1842 the Copley Medal of the Royal Society. Overwrought, he died by his own hand on October 24, 1847, at the age of thirty-eight. Last in this group is David Mushet (1772–1847), who died at the age of seventy-four. He is perhaps best remembered for his important discovery of the Black Band Ironstone through which many fortunes were made; but he did notable work in other directions, one authority writing that "He found the knowledge of iron, and of the ores from which the metal is derived, wrapped in the darkness of barbarism; he evolved and brought to light the true principles of both by a series of experiments, in which the most patient investigation and untiring bodily labour were combined".

At a time when so much thought is being devoted to technical education, it is worth recalling that the earliest modern technical colleges were those founded by the French Government in the eighteenth century. One of these was the École des Ponts et Chaussées, inaugurated just two hundred years ago by the administrator, Daniel Charles Trudaine, with the famous engineer, Jean Rodolphe Perronet (1708–94), "the Telford of France", as its director. The Corps des Ponts et Chaussées had been organised in 1716 for the maintenance of the roads, bridges, canals and harbours of France; and the School was for preparing likely candidates for the Corps. "The Corps and the School," said Mr. S. B. Hamilton, "closely associated, formed a professional body of men specializing in civil engineering, as distinct from military engineering, and from architecture. From this period, therefore, we may regard the separation of the three professions as having become effective." The School had many students who distinguished themselves, and one of these was Jacques-Élie Lamblardie (1747–97), who succeeded Perronet as director and held that position at the time of the Revolution, when for a time the School was merged in the École Centrale des Travaux Publics. He had previously done good work on the rivers and harbours of Normandy, erected a bascule bridge at Le Havre, and commenced a series of large-scale tests on timber, which were after his death continued by his colleagues.

Of never-ending interest is the period which saw the work of Huygens, Newton, Boyle, Leibniz and Hooke, and the founding of the Royal Society and the Academies of Sciences in Paris, Berlin and elsewhere. All these men and institutions are recalled by the lives of Denis Papin and Mårten Triewald. Papin was born three hundred years ago, and Triewald died two hundred years ago. At various times the assistant of Boyle, Huygens and Hooke, correspondent of Leibniz, curator of the Royal Society and the first to show how to construct an atmospheric machine having cylinder and piston, Papin once wrote to Leibniz in 1696: "The number of machines and new inventions which I have in my head becomes ever greater, and I have no stronger desire than to live to see their effect, which they will produce as soon as they can be properly constructed". One of the things Papin sought to do, Thomas Newcomen achieved, and part of Triewald's fame is due to the construction by him of the first Newcomen atmospheric pumping engine seen in the Swedish mines. His stay of ten years in England had made him known to Newton and Desaguliers, and back in his own country he lectured here and there on experimental science. He also made a collection of instruments still preserved in the University of Lund. An active, energetic and versatile man, he was one of the six founders of the Royal Swedish Academy of Science. A translation of his "Short Description of the Atmospheric Engine" (1734) was published by the Newcomen Society in 1928. Papin was born at Blois, France, on August 22, 1647, and died some time after 1712. Triewald was born in Stockholm, being baptized on November 21, 1691; he died on August 8, 1747. Papin is also remembered for his invention of the digester known by his name. It is recorded by Evelyn that Papin cooked a meal for some fellows of the Royal Society in his digester: "This philosophical supper caused much mirth amongst us and exceedingly pleased all the company".

In 1908 the tercentenary of the birth of Evangelista Torricelli was celebrated at Faenza. Later on, under the auspices of the municipality of that town, his collected works were published in three volumes; a review of them appeared in *Nature* of January 29, 1920. This year marks the tercentenary of his death, and also of that of his countryman, Bonaventura Cavalieri, who was born ten years before Torricelli. One has an assured place in the history of science for his discovery of the pressure of the atmosphere and his invention of the barometer; while the other is remembered among mathematicians for his method of indivisibles. The two men were friends of Galileo, through whom Cavalieri was appointed to the chair of mathematics in the University of Bologna. In France, the year 1647 saw the death of Claude Mydorge, an associate of Descartes and Fermat, and a member of the small society from which sprang the French Academy; while in Copenhagen on October 8, 1647, the death occurred of Christian Longomontanus, who worked during 1589–98 with Tycho Brahe at Uraniborg, and from 1605 until his death held the chair of mathematics at Copenhagen.

Finally, looking back yet another century, in 1547 Johann Schoner, the contemporary of Copernicus, died at the age of seventy. For many years he was a professor of mathematics in Nuremberg, and wrote on the globes, geography, dialling and astronomy. It was to him that the enthusiastic Rheticus wrote after visiting Copernicus: "Believe me, most learned Schonerus, that this man, my instructor, in all kinds of learning, and in the science of astronomy, is not inferior to Regiomontanus. I freely compare him to Ptolemy; not that I think Regiomontanus less than Ptolemy, but because my preceptor has a felicity in common with Ptolemy, that, by the Divine Assistance, he would finish the Reformation of Astronomy; whereas Regiomontanus, O cruel fate! died before he had erected his pillars".

OBITUARIES

Dr. Hugo Obermaier

WITH the death of Hugo Obermaier, which has recently taken place at Fribourg in Switzerland, prehistorians have lost a pioneer colleague of international reputation, the author of at least two widely known books and numerous important articles which have appeared in learned journals; his friends a figure beloved for the unselfish dignity and fidelity of his nature; and the Continent of Europe one of those, alas, now all too rare learned men to whom frontiers are unimportant. He was a good European —if a saddened one.

Born in 1877, the son of the civic librarian of Ratisbon in Bavaria, he studied in Vienna under Hoernes and others, and early developed a flair for prehistory, working at pleistocene geology with the famous Albrecht Penck. In 1904 he went to Paris, and there first met his life-long friend, the Abbé Breuil. The latter has told me the following anecdote of Obermaier at this time which is characteristic of his fine personality. It appears that he was hoping to be elected to a chair at Fribourg, not knowing that his new friend, too, had similar ambitions. When he learnt the position, he told Breuil at once that he was no longer a candidate, adding: "I indeed prefer your friendship to this chair".

In 1909 Obermaier was associated with Breuil and the late Prince of Monaco in excavating the great prehistoric home-site at Castillo in North Spain, and a few years later, when the Prince founded the Institut de Paléontologie humaine at Paris, he was named as one of the professors. He travelled much with Breuil at this time both in France and Spain, studying sections, home-sites and cave art. The fateful year 1914 found him concluding the excavations at Castillo, and he remained in Spain throughout the First World War, being granted a small post at Madrid. Later he accepted Spanish nationality. Between the wars he worked in Spain, until the Spanish civil war drove him to Switzerland, with the loss in Madrid of many valuable papers. When the Second World War broke over Europe, he was occupying a post in Fribourg, where he was laid low by a stroke some months ago, and has recently died. Like Breuil, he was a Roman Catholic priest, but, again like his colleague, he never held a cure of souls.

Prof. Obermaier's quaternary geological work, both in the Pyrenees and the Cordillera Cantabrica, was a real contribution to knowledge, as, too, were his numerous excavations and his work at the painted cave of Pileta in the extreme south of Spain. The personal impact of the tragedy of three wars in his learned life may perhaps have prevented the full stature of his mind from making itself felt as widely as it might otherwise have done; but those who knew him always felt and deeply respected the relentless integrity of his mental powers as much as they loved his personal qualities. They can only regret his passing—knowing that science has lost in him an honest and tireless investigator.

M. C. BURKITT

Prof. J. Bečka

THE November issue of *Chemické Listy* records the death at Mauthausen camp on February 25, 1942, of the biochemist, Dr. Jan Bečka, three days after his fifty-third birthday. Prof. Bečka graduated at Prague in both medicine and the natural sciences, and his first researches established the chemical and physical identity of certain types of keratin from various sources. In 1919 he became lecturer in chemistry at the Brno Veterinary College and was appointed professor in 1926, which post he held until the College was closed in 1939.

Bečka's later researches related to problems of ion exchange in pathological conditions, and he studied the effects of calcium and phosphorus in cases of narcosis. He was especially interested in mineral metabolism, and made elaborate studies of the effects of magnesium in animal metabolism. Most of his publications (eighty-six in all, or more than a hundred if those with students are included) appeared in Continental journals, and though some of his earlier researches were known to British colleagues, his last two books on the biochemistry of healing (1940) and the biochemistry of cancer (1941) probably remain unknown outside Czechoslovakia.

Bečka frequently visited Britain, Canada and the United States; he was responsible for introducing the use of insulin into Czechoslovakia.

J. K. Lubanski

JOZEF KAZIMIERZ LUBAŃSKI, a Polish physicist who was working at the Laboratory for Aero- and Hydrodynamics of the Technical University at Delft, died on December 8, at the age of thirty-two. After having obtained the degree of *magister philosophiæ* at Wilna in 1937, and worked for two years as an assistant in theoretical physics at Polish universities, Lubanski obtained a grant in order to travel to Holland and to work under Prof. H. A. Kramers at Leyden. His original intention was to go to Copenhagen in the following year; the War prevented this, and for some time he worked with Prof. L. Rosenfeld at Utrecht. A number of papers dating from this period, mostly in *Physica*, one in the *Arkiv för Matematik, Astronomi och Fysik*, deal with the properties of mesons and similar particles considered in relation to quantum mechanics.

Since the autumn of 1945, Lubanski had been assistant at the Laboratory for Aero- and Hydrodynamics of the Technical University at Delft. He studied with considerable success the theoretical aspects of this subject, but he had not yet published any of his work.

Lubanski's death is felt as a great loss by his many friends; he was much liked both for his personal character and for his scientific knowledge, as well as for that of philosophy and general literature.

J. M. BURGERS

Prof. J. G. Koenigsberger

NEWS has been received of the death of Prof. Johann Georg Koenigsberger, 33 Wildtalstrasse, Freiburg i. Breisgau (17B), French Zone, Germany, in his seventy-first year. Prof. Koenigsberger was well known for his work on the magnetic properties of minerals, and at the time of his death he was in communication with physicists in England with regard to the publication of a paper which he submitted in 1939 and which was held up during the War; the paper was concerned with changes of coercivity with grain size.

Prof. Koenigsberger was suspended from his chair in 1933 and dismissed from the University of Freiburg i. Breisgau in 1934 for having been republican deputy in the Diet of Baden and because of his partly Jewish ancestry. His daughter came to Britain in 1935 and served in the A.T.S. during the Second World War. Koenigsberger was reinstated as professor at the close of hostilities, and carried on theoretical research work under difficulties until the time of his death.

L. F. B.

WE regret to announce the following deaths:

Mr. William Barnicot, M.B.E., secretary of Rothamsted Experimental Station since 1920, on December 30, aged seventy-four.

Prof. Paul Langevin, For.Mem.R.S., director of the École de Physique et Chimie Industrielle, Paris, on December 19, aged seventy-four.

Prof. Edward L. Mark, emeritus professor of zoology in Harvard University, aged ninety-nine.

Mr. C. C. Robertson, formerly chief research officer and professional assistant to the chief conservator of forests, Department of Forestry, South Africa, on December 3, aged sixty-two.

Mr. R. N. Vyvyan, formerly engineer-in-chief of the Marconi Co., and one of the pioneers of radiocommunication, on December 14, aged seventy.

NEWS and VIEWS

New Year Honours List

The names of the following men of science and others associated with scientific work appear in the New Year Honours List:

O.M.: Field Marshal J. C. Smuts.

Hon. O.M.: Mr. John Winant.

Viscount: The Right Hon. S. M. Bruce, chairman of the International Emergency Food Council.

Baron: Sir Ernest Simon, for public services.

G.C.B.: Sir Alan Barlow, second secretary, H.M. Treasury.

K.C.V.O.: Evelyn C. Shaw, secretary to the Commissioners of the Exhibition of 1851.

Knights: Major G. St. J. Orde Browne, labour adviser, Colonial Office; Major-General H. C. Buckley, formerly principal of the Medical College, Agra; Dr. W. H. Coates, a deputy-chairman of I.C.I., Ltd., for services to Government departments; Prof. Kerr Grant, professor of physics in the University of Adelaide, for public services; Prof. W. N. Haworth, Mason professor of chemistry and director of the Chemistry Department, University of Birmingham; Prof. C. E. Hercus, professor of bacteriology and preventive medicine and dean of the Medical School, University of Otago; Dr. E. W. Smith, lately president of the Institute of Fuel; R. Thomas, agricultural adviser to the Government of Sind, and managing director of Sind Land Development.

C.B.: Air Commodore F. Whittle.

C.M.G.: Prof. P. A. Buxton, professor of entomology in the University of London and director of the Department of Entomology, London School of Hygiene and Tropical Medicine; A. D. Storke, for services in connexion with mineral resources in the Colonial Empire.

C.I.E.: A. P. F. Hamilton, inspector-general of forests, India; Colonel O. Slater, director of the Survey of India; Lieut.-Colonel W. J. Webster, senior assistant director, Central Research Institute, Kasauli.

C.B.E.: Prof. F. T. Brooks, professor of botany in the University of Cambridge; O. V. Guy, secretary of the Cambridge University Appointments Board; Prof. T. D. Jones, professor of mining in the University of Wales, and director of the Mining Research Laboratory, University College, Cardiff; Dr. F. C. Toy, director of the British Cotton Industry Research Association; Prof. T. Wallace, director of the Bristol University Agricultural and Horticultural Research Station, Long Ashton.

Indian Science Congress Association

The Indian Science Congress Association is meeting in Delhi during January 2–8 under the presidency of Pandit Jawaharlal Nehru. The general theme of the meeting is research and national planning. The executive committee of the Association has taken an initiative among Associations for the Advancement of Science in planning to make its annual meetings international occasions; strong delegations of men of science from a number of countries will attend the meeting at Delhi, and some will remain in India for a number of weeks visiting centres of individual interest, lecturing and advising. The British delegation, appointed by the Royal Society and the British Association, includes Prof. P. M. S. Blackett, Prof. W. Brown, Sir Charles Darwin, Sir Arthur Fleming, Prof. H. Munro Fox, Sir Harold Spencer Jones, Prof. L. J. Mordell, Prof. L. Dudley Stamp and Sir D'Arcy Thompson. The British party travelled from London Airport in company with the delegations from Canada, the United States and France.

Charles L. Mayer Award: Dr. C. Jayaratnam Eliezer

A Charles L. Mayer Award of 2,000 dollars, offered by the National Science Fund of the U.S. National Academy of Sciences for an essay on the nature of light, has been allocated to Dr. C. Jayaratnam Eliezer, for a paper on "The Interaction of Particles and an Electromagnetic Field". Dr. Eliezer, who is twenty-eight years old, is a native of Ceylon. After a distinguished career at the Ceylon University College, he entered Christ's College, Cambridge, and read for the Mathematical Tripos. He began research studies in quantum mechanics under the supervision of Prof. P. A. M. Dirac, and won an Isaac Newton Studentship and a Smith's Prize. During 1943–46 he was lecturing at the University of Ceylon, returning to Cambridge in 1946 as a research fellow of Christ's College. A second Charles L. Mayer Award was offered but was not awarded, no other essay received being considered suitable.

Sir Ben Lockspeiser

As announced in *Nature* of December 14, p. 867, Sir Ben Lockspeiser has been appointed chief scientist to the Ministry of Supply. Sir Ben, who is fifty-five, was at Sidney Sussex College, Cambridge. During the First World War he served in Gallipoli and Egypt. He afterwards worked at the Admiralty's Laboratory at Sheffield, and was for a time in the Inventions Department of the Ministry of Munitions. He joined the Royal Aircraft Establishment in 1921. His first work was to assist Dr. A. A. Griffith in investigations on phase complexity and on stress concentration in plastic crystals. He turned his attention, at the R.A.E., to a variety of aeronautical problems, such as wing flutter, instrument design, the design of windscreens and the prevention of ice accretion. Sir Ben was responsible, with Dr. Ramsbottom, for the development of the early form of chemical anti-icing device consisting of a porous wing nose-piece kept saturated with ethylene glycol, afterwards manufactured by the Dunlop Rubber Co. In 1936 he transferred to the Air Defence Department of the Royal Aircraft Establishment, where he was closely concerned with the development of the balloon barrage in the form in which it played an important part in defence during the Second World War, his work including theoretical aspects of the interception problem, practical trials and the effect of the employment of the barrage on aircraft design.

In 1939, Sir Ben moved to Air Ministry headquarters as assistant director of scientific research. In the Ministry of Aircraft Production he became in 1941 deputy director with responsibility for research on armaments, including fuses and aerial mine barrage schemes. He succeeded Dr. D. R. Pye as director of scientific research in 1943, and was made a director-general in 1945. He was knighted in January 1946.

Physical Society Awards:

Duddell Medal

The twenty-third Duddell Medal of the Physical Society has been awarded to Dr. Karl Weissenberg, of the Shirley Institute, Didsbury, Manchester, in recognition of his invention and development of X-ray goniometers, the first of which was described in 1924, when he was engaged in the Institute for Fibre Chemistry of the Kaiser Wilhelm Institut. In this instrument the rotation of the crystal is linked to the to-and-fro movement of a cylindrical photographic film parallel to its axis during the exposure. The diffracted spots are thus connected with the orientation of the crystal, are recorded without overlapping, and are readily indexed. The instrument was almost before its time, for the full value of photographic methods, and especially of the rotation method, was not then realized, except perhaps by Weissenberg himself. With the development of the method of the reciprocal lattice and of Fourier synthesis of complex structures, however, the Weissenberg goniometer has become almost indispensable. It is now widely used, and has been responsible for a great advance in our knowledge of crystal structure.

Dr. Weissenberg pointed out at the time that his design embodied only one possible combination of crystal and film movements; and that others, which he described, were likely to be useful. These have since been embodied in other designs; in the double Weissenberg goniometer comparison is made with a standard crystal, so that intensity measurements shall be on an absolute scale. But the original Weissenberg goniometer is still that most generally used. The presentation of the Duddell Medal will take place at a science meeting of the Physical Society at the Science Museum, South Kensington, on January 10.

Charles Vernon Boys Prize

The Council of the Physical Society has made the second (1946) award of the Charles Vernon Boys Prize to Robert William Sutton, superintendent scientist at the Admiralty Services Electronics Research Laboratory, Baldock, Herts, for his work in the development of receiving valves and cathode-ray tubes for radio and radar, notably the velocity-modulated local oscillators (the Sutton valve) for use on centimetric waves, and the Skiatron tube by means of which a picture can be produced from a radar beam. Sutton's research career began in 1929 at the Imperial College of Science and Technology, where he collaborated with Prof. G. I. Finch in a successful study of the induction coil. He afterwards went to Ferranti, Ltd., where he brought the valve factory into efficient operation, to E. K. Cole, Ltd., and to Scophony, Ltd., where he was primarily interested in television research. Early in 1939 Sutton was appointed a senior scientific officer at the Admiralty Signal Establishment (School at that time) and given charge of the research section of the valve division; he became principal scientific officer in 1944 and superintendent scientist in 1945. The award will be presented to Mr. Sutton at the meeting of the Physical Society on January 10.

British Council Science Office in China: Dr. R. A. Silow

Dr. R. A. Silow, until recently scientific officer of the Agricultural Research Council at the Plant Breeding Institute, Cambridge, has been appointed director of the British Council's Science Office in China, in succession to Dr. Joseph Needham, who is now with the United Nations Educational, Scientific and Cultural Organisation. Dr. Silow is a graduate of the University of Reading in agricultural botany. He did research in genetics at the Welsh Plant Breeding Station, Aberystwyth, during 1929–33. He then went to the Empire Cotton Growing Corporation's Cotton Research Station, Trinidad, B.W.I., remaining there until 1944. He was visiting professor of plant genetics at the Blandy Experimental Farm of the University of Virginia during 1944–45; after which he became scientific officer of the Agricultural Research Council, attached to the Plant Breeding Institute, School of Agriculture, University of Cambridge. His work has included investigations on Asiatic cottons in collaboration with the Chinese Agricultural Research Bureau at Nanking.

Trans-uranium Elements in Chemistry

Delivering this year's Harrison Howe Lecture on November 18 to the Rochester Section of the American Chemical Society, Prof. G. T. Seaborg referred to the importance which the newly discovered trans-uranium elements may achieve for general chemistry. Those of comparatively short life-time, and therefore high radioactivity, will always require special training for their safe handling; consequently, neither plutonium (element 94), nor americium (element 95), which only recently has been prepared in pure form, can be handled without certain precautions; neptunium (element 93), however, with a life-time of more than two million years, may eventually find its way into the ordinary chemical laboratory as one of the rarer elements. Curium (element 96), which so far occupies the last place in the Periodic System, is remarkable in being the element with the highest atomic weight; Prof. Seaborg expects that, in addition to the isotope 242, which is produced by the neutron bombardment of americium, still heavier ones with atomic masses up to 246 may be obtained.

British Association of Chemists: Annual General Meeting

R288

The twenty-ninth annual general meeting of the British Association of Chemists was held on December 7. Prof. R. G. W. Norrish, retiring president, presented the Hinchley Medal to Mr. C. S. Garland, and in doing so he paid tribute to the work which Mr. Garland had done for the Association over a long period of years and for the profession of chemistry. The following officers for the ensuing year were elected: *President*, Norman Sheldon; *Vice-Presidents*, Prof. R. G. W. Norrish, Dr. J. B. Matthews, J. Wilson and C. A. Wylie; *Hon. Secretary*, J. Stewart Cook; *Hon. Treasurer*, W. C. Peck; *Hon. Registrar*, H. L. Howard; *Hon. Editor*, T. Crosbie Walsh. Two proposed alterations to the rules of the Association were adopted. One gave authority to increase benefits, under the Unemployment Benefit Fund, and the other established the office of honorary life vice-president, to which Prof. E. C. C. Baly was elected, in recognition of the valuable work he had done for the Association during the past years. A resolution, from the Manchester Section, was adopted to put the Association's political fund into active operation. There would be no suggestion of assisting any particular political party; the object was to assist chemists to play their part in public affairs, and to let them feel that they had the goodwill of their fellows.

In assuming the office of president, Mr. Sheldon made a statement of policy. The British Association of Chemists is not, nor does it pretend to be, a qualifying body; but it is the only organisation which exists for the sole purpose of looking after the economic interests of the chemical profession. It gives members financial support from its Unemployment Benefit Fund, which has a reserve of more than £42,000; and it is exploring the possibility of setting up a superannuation scheme which will be transferable when a member moves from one firm to another. It is also hoped to extend the unemployment benefit scheme to cover loss of income through sickness or accident. A comprehensive appointments service is provided. The Association aims at recognition by industrial firms, Government departments and public authorities as the appropriate body with which all matters relating to the economic interests and the status of chemists should be discussed. To this end it is registered as a trade union; but it is not in any way associated with any particular political party. An important activity of the Association is the formation of student groups through which students of chemistry can take an interest in matters concerning their present and future economic welfare, and secure the co-operation and advice of the senior members.

New Culture Medium for *Penicillium notatum*

In the absence of supplies of penicillin in Hungary during the War, Dr. E. Rosenthal, of St. Roch's Hospital, Budapest, isolated two strains of what appeared to be *Penicillium notatum* Westling from which were prepared filtrates exhibiting antibiotic activity against isolated strains of *Staphylococcus albus*. Since glucose or other forms of sugar required for the usual culture media were extremely difficult to obtain, substitutes were sought. The urine of diabetic patients was ultimately found to provide a good culture medium for the mould, and, for the routine production of penicillin-active filtrates, was adjusted to contain 4 per cent of sugar. The acidity was adjusted to the usual *p*H of the Czapek-Dox medium and, after filtration and sterilization, the urine was inoculated with the spores of the mould. In comparison with the Czapek-Dox medium, diabetic urine produced in most instances accelerated development of the mould with the appearance of as much as three times the amount of antibiotic activity. Similar results were usually obtained with a medium prepared by the addition of 4 per cent of glucose to normal human urine. The addition to a culture medium of substances such as indol-acetic acid is known to stimulate penicillin production, and the results obtained with diabetic urine are probably to be ascribed to the presence therein of stimulating substances of this and other types.

Disappearance of a Mendel Manuscript

Dr. Jaroslav Kříženecký, of the Zootechnical Research Institute and College of Agriculture in Brno, Czechoslovakia, has informed Dr. Herbert C. Hanson, chief of the Agricultural Division, United Nations Relief and Rehabilitation Administration Mission to Czechoslovakia, that Mendel's manuscript "Versuche über Pflanzen Hybriden" has disappeared. This manuscript had been in the custody of the Natural History Society in Brno since 1910, when it was found by Prof. Hugo Iltis in a waste-paper basket in the Society's library. In 1939, when the Germans occupied Brno, Dr. Otto Richter, professor of botany in the German Technical College in Brno, took over the chair of plant physiology in the Faculty of Science in the Masaryk University. All the buildings and facilities of this University were turned over to the German College. Some of the Czech assistants were persuaded to remain under Richter. They have informed Dr. Kříženecký that Prof. Richter, after he had taken over the apartments of the Natural History Society, carried Mendel's manuscript about with him in his brief-case. Richter was also a student of Mendel's history and wrote several publications about Mendel during the War. When the Germans were evacuating Brno upon the approach of the Russians, Richter disappeared. It is thought that he may have taken Mendel's manuscript with him either to Germany or Vienna. So far, the whereabouts of Prof. Richter and of the manuscript are unknown. It is to be hoped that further official aid will be given in searching for this interesting document, which should be returned to Brno.

Tibetan Culture

Tibet has always been a mystery land, and even now little is accurately known of its story. Cheng Te-k'un and D. Michael Sullivan, in No. 6 of the Guidebook Series issued by the West China Union University Museum, Chengtu, Hwasipa, have produced a pamphlet of forty pages intended to supply this need. Much information is given, even if in a rather dull manner and without any illustrations. Anyone wanting to know something of the dry bones of Tibetan history will find much that he is seeking here.

Polar Exploration Exhibition

An exhibition illustrating the story of polar exploration to the present day is open to the public at the Royal Geographical Society's House (Exhibition Road entrance) during January 4–18 inclusive, 11 a.m. to 4 p.m. daily, except Sundays. The history of polar exploration is shown by paintings, prints, maps and photographs as well as personal relics of famous polar explorers; and a selection of modern equipment, including that used by the Royal Navy, the Army and the Royal Air Force, demonstrates modern technical developments.

Conference on Pulverized Fuel

A conference on pulverized fuel is being organised under the auspices of the Institute of Fuel and will be held in Harrogate during June 3–6. Some fifty papers have been promised from authorities in Great Britain, and contributions are also expected from South Africa, Australia, the United States, France, Holland and Germany. The papers are to be published in a book which will be sent four weeks before the opening session to all who take up membership of the conference. This book will contain, as well as the papers, an index to authors, an index to subjects, and the programme for each session. Each programme will set out the points to be discussed at that session with a cross-index to the comments of the authors upon them. Each session will be devoted almost wholly to discussion, following a short survey outlining the topics for that session. Membership of the conference will be open to anyone interested in pulverized fuel. Particulars can be obtained in due course from the Pulverised Fuel Conference Committee, Institute of Fuel, 18 Devonshire Street, London, W.1.

University of London : Appointments

The title of professor emeritus of physics in the University of London has been conferred on Dr. Sydney Russ on his retirement from the Joel chair of physics which he has held at the Middlesex Hospital Medical School since 1920. He has been succeeded by Dr. J. E. Roberts, formerly assistant physicist in the School.

The title of professor emeritus of Chinese art and archæology in the University has been conferred on Dr. W. P. Yetts on his retirement from the chair of Chinese art and archæology at the Courtauld Institute of Art which he has held since 1932.

Dr. Reinhold Fürth has been appointed to the University readership in theoretical physics tenable at Birkbeck College as from January 1. During 1931–39 he was professor of experimental physics and head of the Physics Department in the University of Prague, and since 1942 he has been on the staff of the University of Edinburgh as Dewar Research Fellow and part-time lecturer.

The title of reader in the University has been conferred on the following in respect of the posts they already hold: Dr. G. B. Brown (physics), University College; Dr. F. C. Champion (experimental physics), King's College; Dr. E. T. Davies (mathematics), King's College; Dr. Benjamin Dawes (zoology), King's College; Mr. M. B. Donald (chemical engineering), University College; Dr. M. S. Fisher (metallurgy), Imperial College of Science and Technology; Dr. G. W. Himus (fuel technology), Imperial College of Science and Technology; Dr. C. C. N. Vass (physiology), St. Thomas's Hospital Medical School; Dr. M. J. D. White (zoology), University College; Mr. E. W. Yeoman (metallurgy), Imperial College of Science and Technology.

The degree of D.Sc. has been conferred on Mr. E. E. Cheeseman, Imperial College of Science and Technology; Mr. C. W. Davies, recognized teacher at Wye College; Mr. R. L. Noble, Middlesex Hospital Medical School; Mr. J. M. Watson, recognized teacher at Northern Polytechnic.

Earth Tremor in Scotland

On December 25, soon after 5 p.m., an earth tremor was felt in the Lochaber district of Inverness-shire. It is reported to have begun with a faint rumbling noise, which increased to a loud roar and continued for some seven seconds. The earth tremor rattled crockery on the shelves in houses at Spean Bridge, and the shock was faintly felt at Fort William. No damage has been reported. The tremor was no doubt caused by slipping along one of the faults associated with the Highland boundary.

The Night Sky in January

Full moon occurs on Jan. 7d. 04h. 47m., U.T., and new moon on Jan. 22d. 08h. 34m. The following conjunctions with the moon take place: Jan. 8d. 12h., Saturn 4° S.; Jan. 16d. 13h., Jupiter 0·6° S.; Jan. 18d. 03h., Venus 4° N. Mercury is a morning star, rising at 7h. 23m. on Jan. 1, and is in superior conjunction on Jan. 23. At the end of the month the planet rises about quarter of an hour after the sun and is not then well placed for observation. Venus is a morning star, rising at 4h. 23m., 4h. 27m., and 4h. 42m. at the beginning, middle and end of the month respectively. The planet attains its greatest westerly elongation on Jan. 28. Mars, in conjunction on Jan. 6, is too close to the sun for favourable observation. Jupiter is visible in the early morning hours, rising at 4h. on Jan. 1 and 2h. 30m. on Jan. 31. Saturn is visible through the greater portion of the night, rising at 18h. 17m., 17h. 17m., and 16h. 06m. at the beginning, middle and end of the month respectively, and is in opposition on Jan. 26. The following occultations of stars brighter than magnitude 6 take place: Jan. 5d. 21h. 58m., 132 Taur. (*D*); Jan. 31d. 20h. 57·2m., ω Taur. (*D*); *D* refers to disappearance, and the latitude of Greenwich is assumed. The earth is at perihelion on Jan. 4, its distance from the sun then being 91,449,000 miles.

Announcements

Mr. Kenneth B. Disher has been appointed director of the Cleveland Museum of Natural History, Cleveland, Ohio. He was formerly executive secretary of the Allegany State Park Commission, New York, and prior to that associated with the National Park Service, U.S. Department of the Interior. Mr. Disher is a graduate of Pomona College and has also worked at Harvard University.

Dr. E. A. Stewardson has been appointed to the newly established chair of physics at University College, Leicester.

Dr. R. J. Sarjant, head of the Research Department of Messrs. Hadfield's, Ltd., known for his work on a wide range of fuel problems, especially those relating to the steel industry, has been appointed to the chair of fuel technology in the University of Sheffield; this chair has been vacant for several years.

Anticipating a further increase in advisory work in 1947, the Board of Greenkeeping Research has appointed Mr. J. H. Arthur as an additional advisory officer at the St. Ives Research Station, Bingley, Yorkshire. Mr. Arthur graduated at the University of Reading in 1946 after serving five years in the Army.

Mr. F. A. Fox, chief metallurgist of Magnesium Elektron, Ltd., is joining the British Welding Research Association as assistant director of research. Mr. Fox has been engaged in metallurgical research, particularly in the light alloys, since 1934, in both the ferrous and non-ferrous fields, and has had considerable experience in the organisation of this kind of work.

A course of twelve lectures on television practice will be given on Friday evenings at 7 p.m. commencing on January 17 in the Electrical Engineering Department, Northampton Polytechnic, St. John Street, London, E.C.1. The fee for the course is 15*s*.

A conference on "The Family at Work and Play", to be held at the Institution of Civil Engineers on January 16–17, is being organised jointly by the British Social Hygiene Council and the Town and Country Planning Association. The conference will be opened by a paper by Mr. Gilbert McAllister on "The Family and the Nation". Other papers will be given during the following sessions: "The Family at Home"; "The Family at School"; "The Family Growing Up"; "The Family at Work"; and "The Family at Play". Further information can be obtained from either the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1, or the Town and Country Planning Association, The Planning Centre, 29 King Street, Covent Garden, London, W.C.2.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Technetium: the Element of Atomic Number 43

In 1937, Perrier and Segrè showed that radioactive isotopes of element 43 could be formed by neutron or deuteron bombardment of molybdenum[1]. Several chemical properties of element 43 were established at that time, and some nuclear properties of the spectral isotopes. These isotopes were found after nuclear bombardments by the 37-in. cyclotron of the Radiation Laboratory of the University of California.

Later on, Wu and Segrè found also element 43 among the fission products of uranium, a source from which relatively large amounts of 43 can be isolated[2].

It seems appropriate now to give a name to this element, as suggested by Paneth[3]; and we would like to propose the name of 'technetium', from the Greek τεχνητός, artificial, in recognition of the fact that technetium is the first artificially made element. The corresponding chemical symbol should be 'Tc'.

C. Perrier

University of Genoa,
Italy.

E. Segrè

University of California,
Berkeley, California.

Nov. 29.

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[1] Perrier, C., and Segrè, E., *J. Chem. Phys.*, **5**, 712 (1937); **6** (1938).

[2] Segrè, E., and Wu, C. S., *Phys. Rev.*, **57**, 552 (1940).

[3] Paneth, F. A., p. 8 of this issue of *Nature*.

Astatine: the Element of Atomic Number 85

In 1940, we prepared the isotope of mass 211 of element 85 by bombarding bismuth with alpha particles accelerated in the 60-in. cyclotron of the Radiation Laboratory of the University of California[1]. At that time we established several chemical properties of element 85 and we made a fairly complete nuclear study of the isotope formed.

It has been pointed out to us[2] that a name should now be given to this new element, and following the system by which the lighter halogens, chlorine, bromine and iodine, have been named, namely, by modifying a Greek adjective denoting some property of the substance in question, we propose to call element 85 'astatine', from the Greek ἄστατος, unstable. Astatine is, in fact, the only halogen without stable isotopes. The corresponding chemical symbol proposed is 'At'.

D. R. Corson

Cornell University,
Ithaca, N.Y.

K. R. Mackenzie

University of British Columbia,
Vancouver, B.C.

E. Segrè

University of California,
Berkeley, California.

Nov. 29.

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[1] Corson, D. R., Mackenzie, K., and Segrè, E., *Phys. Rev.*, **57**, 1087 (1940).

[2] Paneth, F. A., p. 8 of this issue of *Nature*.

British Universities and 'Secret' Theses for Degrees

In his presidential address to the Royal Society, Sir Robert Robinson is reported in *Nature* of December 7 (p. 825) as having said, "Nevertheless, the universities have preserved intact their precious liberty of action, and I see no signs of any attempt to curtail it. Surely this suggests a feasible line of demarcation in that extra-mural contracts, placed by Service departments with the universities, need not, and should not, contain any clauses restricting free publication of the results. Although it has sometimes been irksome, the refusal of many universities to accept theses that cannot be published is a step in the right direction."

Whatever the views and practices of the Defence Departments may have been in the pre-war and war-time years, it is certain that those now responsible for the organisation and direction of defence research in Great Britain are as genuinely interested as academic scientists themselves in the maintenance of complete independence and liberty of action for British universities in the field of scientific research. Within the last year, defence science representatives have met to pool their views on policy in the placing of extra-mural contracts, and were unanimous in deprecating any form of pressure on the universities to accept research contracts of the kind which seem likely to lead to unpublishable results.

But Sir Robert Robinson's commendation of the refusal of many British universities to accept unpublishable theses must not pass unchallenged. Since no scientific worker doing research in a university laboratory should be producing unpublishable results, there should arise no demand on universities to grant 'internal' degrees based on secret theses. The undertaking of research in a university laboratory is, however, not an invariable requirement for the award of higher degrees such as M.Sc., Ph.D., and D.Sc., and the refusal to award such degrees to 'external' scientific workers on unpublishable results deprives the young research worker entering a Government defence laboratory of any *assured* opportunity to submit the results of his research for a higher degree.

Non-acceptance of unpublishable theses by universities thus becomes a serious handicap to recruitment of scientific men for defence research. In addition, it is a potential handicap to the defence research worker whenever he may seek return to a university or industrial scientific career, for there is no denying that the possession of a research degree is an asset when seeking a scientific appointment, and it is likely to be the more needed if, for security reasons, one is prevented from describing one's research achievements in detail.

Bearing in mind how seldom it proves impossible to distil the scientific essence of a defence investigation from those operational aspects and implications which must remain secret, I would estimate that not more than four or five scientific men in defence establishments would wish to submit unpublishable theses each year to universities in Great Britain, and most, if not all, of these theses would become publishable within the space of a few years. The injury to national defence by refusal to accommodate these few scientific workers on an equal footing with colleagues in the academic and industrial world is surely disproportionate to any slightly harmful reaction upon the universities which the idealist may discern.

Sir Robert Robinson rightly points out that "it is inconsistent to praise our scientists for their outstanding contributions to the war effort and at the same time to suggest that they offend against our ethical code if they serve the country in a similar fashion during an uneasy peace". What ethical code would countenance freedom for all scientific workers but those in defence establishments to acquire professional qualifications ? To justify the universities' attitude, it must be shown that something in the process of examining the research work and secret thesis of a defence scientific worker must inevitably so react on the university as to be an infringement upon its scientific liberty and independence. What indeed are the reactions the universities fear, and, with goodwill, can no safeguards be evolved to allay such fears ?

If the realistic approach to this problem now unfortunately being followed by only one or two universities is condemned by scientific leaders, or indeed if it fails to be adopted by a wider circle of universities, it is certain to lead to an accelerated decline in the research talent of our defence laboratories and a degree of unpreparedness in defence that can only make an uneasy peace the more uneasy for us all. Before taking this responsibility on their consciences, universities should satisfy themselves that no compromise can be offered, and I would venture to suggest that the Royal Society might offer to mediate between the universities and the defence science departments in trying to work out some acceptable scheme. Any scientific worker in Great Britain should feel that he can count upon the active support of British science and British universities in alleviating so far as possible conditions which restrict his scientific freedom.

J. E. KEYSTON

Department of Research Programmes
and Planning, Admiralty.
Dec. 12.

THE assurance contained in the second paragraph of Dr. Keyston's letter is very welcome, and it will now be the fault of academic men of science and the universities themselves if the high ideal of unfettered research is not realized in practice.

The citation in the first paragraph shows that my remark about unpublishable theses was intended to apply to 'internal' students. It is clearly bound by juxtaposition and reference to the previous sentence. Thus in my opinion the refusal to accept secret theses from internal students is "a step in the right direction", because it underlines the desirability of freedom of scientific effort in the universities. Admittedly, however, the sentence, taken out of the context, would appear to cover the cases of scientific workers in defence establishments who wish to submit secret theses for higher degrees. A little earlier in the address quoted, it was recognized that such workers would not always be able to publish their results ; an unfortunate consequence of the present state of world affairs. I agree that, with proper safeguards, it might be possible to devise ways and means whereby such results could be examined for a degree.

The matter is nevertheless very complex, and it is certain that a single system has little chance of general adoption. The University of London insists that all theses must be deposited in the University Library, but will examine work by suitably qualified external students. The University of Oxford, on the other hand, has accepted a certain number of secret theses during the War as an emergency measure, but requires residence of three or six terms duration before leave is given to supplicate for the degree of B.Sc. or D.Phil. respectively. The D.Phil., for example, is not regarded merely as a certificate of technical proficiency ; it normally implies that its possessor has spent two years, under approved conditions, in an Oxford school of research. Provision is made for certain equivalents (see Examination Statutes, Statt. Tit. VI, Sect. vi, § 1, 2 and § 5, 2, 12).

These are but two examples of the different regulations in force, and in addition the variables on the side of the defence departments are numerous and include the questions of supervision and assessment of joint work.

I am in no position to estimate the probability of changes being made in the examination statutes, still less to forecast the direction of any such changes, but in view of the very varied circumstances, feel confident that, if the door is opened, each case will still have to be considered on its merits.

Furthermore, I think that there will be a general disinclination to award the higher doctorate on the results of unpublished work. Here again there may well be a few quite exceptional cases, and sufficient elasticity to deal with them is perhaps already provided. Thus at Oxford the Board of Faculties has power to vary the regulations subject to the approval of the General Board of the Faculties.

Where so many parties, interests and principles are involved, I doubt the feasibility of the mediation suggested by Dr. Keyston, and suggest that the problem must still be attacked in detail.

Finally, it should be added that the question affects categories other than scientific men in defence departments, and these include workers in Government laboratories generally, and in industrial research laboratories. These cases are especially important from the point of view of 'external', rather than from that of 'secret' work.

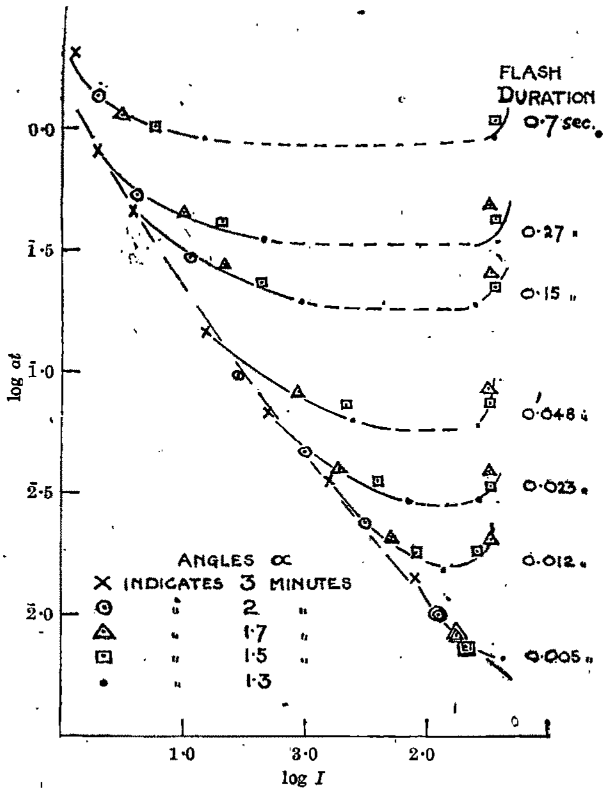
R. ROBINSON

Flash Visual Acuity

MOST published researches on visual acuity have assumed an unrestricted time of observation, but recent studies of the relations between intensity discrimination and acuity, and photo-chemical theories thereof, have indicated that the wandering of fixation plays an important part in the performance of the visual system. It appears that a study of visual acuity in relation to exposure time may throw additional light on the subject.

During the past year, we have conducted some exploratory investigations which we hope will be extended by other workers in this laboratory and published in full ; in the meantime, a note on the results so far obtained may be of interest.

The objects (shown in a dark field) were of the 'double star' type represented by two small equal and adjacent apertures which could be shown alternatively with a single aperture having double the area of a single one. Exposures ranged from 700 msec. to 2 msec., and intensities over a relative range of about 50 : 1. The observer used an artificial pupil, and had to report after a flash exposure whether the object was single or double. Fixation was assisted by the use of a faintly illuminated ring ; some measurements were also attempted for extra-foveal vision. The limiting angles of perception were estimated from a statistical analysis of this one observer's answers. Though many thousands of observations



were made, the results naturally show various uncertainties due to complex psychological factors. We consider that the choice of this type of object has considerable advantages over gratings, etc., for this method of observation, and the results have, moreover, some technical interest in regard to navigation and other signals.

Some of the most significant results, for foveal observations, are shown in the accompanying graph, in which the log of 'visual limiting angle *times* duration of stimulus' is plotted against the log of 'brightness of source'. Looking at the points for 3′ and 2′ visual angles (represented by crosses × and circles ⊙ respectively) there is an approach to a definite relation suggested by the broken-line curve. Results for the given exposure times are connected by other lines, and it will be noticed that the points for 1·7′, 1·5′, and 1·3′ angles do not conform to the same relation. Hence while there is some reciprocity between visual angle and minimum exposure time for the larger angles (the product being roughly a single-valued function of the brightness of the object), this does not generally apply to the smaller angles. The amount of light needed for a given improvement of visual performance, between 1·7′ and 1·3′, at a given exposure time is much greater than would be calculated from the function just mentioned, and the discrepancy increases with the time of the exposure. A similar set of curves has been obtained for observations in which the object appeared at an angle of 0·5° with the (attempted) direction of fixation.

Niven and Brown[1], using a small 'single line' object (the direction of which had to be recognized) found no significant departure from a relation, giving the above product in terms of brightness, derived from Hecht's revised photo-chemical theory[2]; our results are inconsistent with their equation. On the other hand, in investigating the product of the brightness-discrimination fraction and time as a function of intensity, Graham and Kemp[3] found that reciprocity only applied for exposures shorter than a critical value.

If our results are used to plot curves of log 'brightness *times* time' against log 'time' for given visual angles, it appears that there is an approach to reciprocity between brightness and time for the larger angles up to a stimulus duration of about 0·4 sec.; but the critical period, if it exists at all, is apparently smaller for the smaller visual angles.

When studying the effect of increasing the brightness of the field on observing our object with fixed separation and with a constant duration of the flash, it is found that (if the separation is within certain limits) the 50 per cent threshold of correct observations will in general become possible at some level of the field brightness; on further increasing the brightness, the percentage of correct observations will reach a maximum and thereafter decrease. However, the curves flattened at the minima for the longer flashes (see the accompanying figure) are probably caused by the limitation of the retinal structure; the experiments included trials with 1·1′ separations which were not resolved (50 per cent threshold) in these experiments for any level of the brightness. The limiting values at the higher brightness level are much less certain than those at the lower.

The results appear to be consistent with the accepted view that acuity is associated with intensity discrimination, but also lead back to the idea that this discrimination is associated with the production of some minimum difference of concentration of photo-products in adjacent areas of the retina. This would be consistent, for very short exposures, with the reciprocity between visual angle and time for a given intensity, and between intensity and time for a given angular limit. Longer exposures involve increased wandering of the stimulus area over the retina, due to eye movements; this will diminish the chance of setting up the associated liminal concentration difference with weak stimuli, and will conversely tend to prevent an 'over-exposure' effect if the stimuli are too strong.

The application of the above criterion to the usual photo-chemical equation[2] can be made to yield sets of curves similar to those in the figure, but it seems advisable to await the results of fuller experiment (with light-adapted eyes, etc.) before searching for the values of the constants which will represent the results most nearly. It may be remarked, however, that if the short-exposure effects are adequately represented by this equation, the longer-term effects of adaptation may require a modification of its form.

L. C. MARTIN
W. KANIOWSKI

Technical Optics Section, Physics Dept.,
Imperial College, London, S.W.7.

[1] Niven and Brown, *J. Opt. Soc. Amer.*, **34**, 738 (1944).

[2] Hecht, *J. Gen. Physiol.*, **18**, 767 (1935).

[3] Graham and Kemp, *J. Gen. Physiol.*, **21**, 635 (1938).

Origin of Radio Emissions from the Disturbed Sun

IN a recent communication[1] it was pointed out that thermal radiation from the solar corona should be detectable at wave-lengths as long as one or two metres. This source cannot account, however, for the much stronger emissions which are correlated with sunspots[2,3,4]. It has been shown[5,6] that the latter emissions probably come from the immediate vicinity of active sunspots, and would require impossibly high source temperatures of about 10^9 degrees for explanation in terms of thermal radiation.

It is natural first to seek an explanation in terms of the kind of electrical discharge which causes the familiar terrestrial radio noise, namely, lightning flashes; but it is difficult, if not impossible, to see how such discharges could be produced in the always highly ionized solar envelope.

There is, however, a way in which coherent radio waves could be emitted by the ionized gases above the chromosphere. J. J. Thomson[7] showed that an electron gas possesses a natural period of oscillation given by $T = \sqrt{\frac{\pi m}{Ne^2}}$, where m and e are the electronic mass and charge (E.S.U.) and N is the number of electrons per c.c. I have found that in the presence of a magnetic field the medium possesses two such natural periods, both defined by the condition that the dielectric constant of the medium is zero. In the absence of collisional friction, these oscillations could occur without radiation of energy, since the convection current is then exactly neutralized by the displacement current. The presence of even the small amount of such friction present in the solar atmosphere necessitates appreciable radiation. Calculation shows that in the 1–5-metre band radiation from one of the modes of oscillation (which by analogy with Appleton's magnetic-ionic theory of the ionosphere we shall call the 'ordinary' mode) is suppressed by absorption in the overlying layers. On the other hand, radiation from the 'extraordinary' mode will escape from the sun with appreciable intensity. This appears to provide a logical explanation of the observed polarization of this radiation, as previously reported[5].

Calculation shows that the observed radiation is likely to come from the borders of prominence material, which has a somewhat higher density and lower temperature than the surrounding coronal matter. This gives enhanced radiating power in these regions, while the sharp electron gradient reduces absorption of the escaping radiation.

In the regions above active sunspots there is no doubt more than one disturbing influence capable of setting the medium into oscillation. One type of disturbance, however, should be specially important on the borders of moving prominence material. In the presence of the magnetic field of the spots, the transverse motion of ionized matter is accompanied by the setting up of electric polarization on the side walls[8]. We know also that this flow is turbulent, so that eddies are constantly forming along these walls. The continual breakdown of polarization in these eddies can supply enough electrical energy to maintain the oscillation of the medium at the required amplitude.

An interesting but different theory of the abovementioned radiations has been propounded recently by Kiepenheuer[9], who considers that the free spiralling of individual electrons in the magnetic field will produce the observed radiation. It is difficult to see how such motions, which are thermal in origin, could give rise to radiation more intense than that from a black body. Moreover, it is possible to show that the absorption of this radiation must be so great that no appreciable amount can leave the sun. Fuller details of all the relevant calculations will be published elsewhere.

This work is being carried out on behalf of the Council for Scientific and Industrial Research, Australia.

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Nov. 4.

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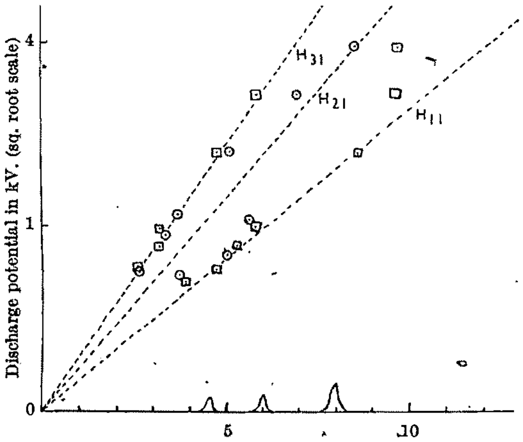
Triatomic Hydrogen and Doppler Effect in Hydrogen Positive Rays

J. J. THOMSON[1] discovered the triatomic molecule of hydrogen by the positive ray parabolic method. It was later confirmed by Dempster[2], Duane and Wendt[3], and several others. Its occurrence is very frequently noted in discharge tubes, but the optimum conditions are not well defined. While investigating the Doppler effect in hydrogen positive rays, using a Wien type of discharge tube, maximum Doppler displacements corresponding to H_3^+ molecules in the discharge space were observed. The accompanying graph gives the maximum Doppler displacements recorded in the $H\delta$ line of the Balmer series. A Steinheil three-prism glass spectrograph was used at two different dispersions, namely, 7·6 A. and 27·2 A. per mm. in the $H\delta$ region.



MAXIMUM DOPPLER DISPLACEMENTS IN THE $H\delta$ LINE, DISPERSION: ⊙, 7·6 A. per mm.; ⊡, 27·2 A. per mm.

The three dotted lines marked H_{11}, H_{21} and H_{31} passing through the origin of the co-ordinate system represent, as explained in an earlier publication[4], the theoretical maximum displacements corresponding to the light emitted by the neutral hydrogen atoms derived from H_1^+, H_2^+ and H_3^+ particles that had fallen through the full voltage applied to the discharge tube. The maximum displacements at each discharge potential used were measured from spectra obtained with graded times of exposure. Great care was taken to eliminate the many-lined spectrum while measuring the respective maximum edges of the Doppler bands.

Starting from a discharge potential of 0·5 kV. and going up to about 2·5 kV., two strips corresponding to H_{31} and H_{11} were measured. The H_{21} strip is not very distinct in this region. Beyond 3·0 kV. and in practice above 2·5 kV., however, the H_{21} strip appeared with increasing intensity, while the H_{31} strip was faint and could not be measured. This discharge potential, namely, 2·5 kV., corresponds in the present investigation to a pressure of 0·09 mm. in the discharge space. For pressures lower than 0·09 mm. the discharge potential would increase beyond 2·5 kV. Hence 0·09 mm. is the minimum pressure below which the H_{31} strip becomes faint. A comparison of the intensities of the H_{31} and H_{11} strips showed that at about 1,120 volts discharge potential they are of the same intensity.

The above results are in good agreement with the observations made by Hornwell[5] using the method of collisions. They differ, however, in certain respects, a discussion of which, along with the details for the rest of the Balmer lines studied, will be reserved for publication elsewhere.

The above work was done in the Positive Ray Laboratory of the Benares Hindu University, and I am grateful to Dr. B. Dasannacharya for his interest in the investigation.

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Vacuum Sublimation of Ice in Bulk

AN ice sublimation or freeze-drying process will have maximum rate of vaporization per unit exposed area of frozen product at a specified temperature if the following conditions are satisfied: (i) The vapour pressure of ice sublimed on the condenser is negligible compared with ice at the product temperature. (ii) The condensing and product surfaces have a uniform and minimum separation. (iii) The permanent gas (usually air) pressure in the product-condenser interspace is a minimum. (iv) Mechanical obstruction (in the form of radiation shields, sterile caps, etc.) to vapour transfer from product to condenser is a minimum. (v) The product is of uniform and minimum thickness. The first four conditions follow from kinetic considerations and ensure that reversed vapour transfer, length of vapour path, and obstruction to vapour transfer are a minimum. The last condition is a consequence of the increase of drying-time with product thickness.

To satisfy these conditions, a plant has been constructed consisting of a tray and condenser within a 500-litre vacuum chamber. The tray and condenser are in the form of rectangular, stainless steel plates, 46 cm. × 76 cm., and are identical apart from the upturned edges of the tray. The horizontal plane of the condenser is 6 cm. above that of the tray. The condenser is maintained at − 80° C. and the tray at any required temperature between − 30° C. and + 60° C. The chamber is evacuated by means of an oil diffusion pump and backing pump, the vacuum line being baffled by the upper surface of the condenser in order to eliminate contamination of the condensing surface by diffusion pump oil and to reduce the mass of water vapour taken through the pumps. Product and other temperatures are measured by means of embedded thermocouples.

Up to 6 litres of liquid to be dried are poured into the tray and frozen to − 25° C. in 30 min. by contact with this surface at − 30° C. The condenser is now cooled to − 80° C. and the chamber evacuated to a permanent gas pressure of one micron of mercury. As in other drying plants[1,2], the tray or equivalent temperature is raised as drying proceeds in order to maintain a maximum vaporization-rate consistent with the nature and condition of the product.

The drying process may be divided into two clearly defined phases. The first is characterized by the uniform recession from the product surface of the horizontal plane of separation between upper partially dry product and lower frozen product. The plane recedes by approximately 1·5 mm. per hour, and this is equivalent to a constant vaporization-rate of 34 μgm. per sq. cm. per sec. This phase terminates when the receding plane of separation coincides with the tray surface. At this stage, 15 per cent of the original liquid bulk remains in the form of isolated ice crystals distributed throughout the partially dried product. Commencement of the second phase of drying is therefore characterized by a rapid fall in the rate of vaporization. The product temperature is now raised from − 10° C. to + 25° C. in 2–3 hours and maintained at this temperature for the remainder of the drying cycle. This is achieved by control of the tray temperature, a final product-temperature of + 25° C. requiring a tray temperature of + 50° C. Two additional hours per litre of initial volume are required for the complete vaporization of these ice crystals. Thus, for most biological fluids, a total drying time of 4 hr. per litre is required to obtain a residual moisture content of less than 1 per cent by weight. Lower moisture contents may be obtained by secondary desiccation over phosphorus pentoxide. At the conclusion of the drying cycle, the underside of the condenser supports an ice sheet of uniform thickness which consists of a mass of ice crystals orientated with the long axis normal to the condenser surface. The bulk density of this ice sheet is 0·7 gm./cm.³. No ice forms on the upper surface of the condenser.

It may be shown[5] that the maximum rate of vaporization from an ice surface into a perfect vacuum is given by the equation $G_{\text{max.}} = 0\cdot244 \dfrac{\alpha P_s}{\sqrt{T}}$ (gm. per sq. cm. per sec.); where P_s mm. mercury is the saturated vapour pressure in equilibrium with the ice surface at absolute temperature T and α is the condensation coefficient. Tschudin[6] has tested this equation for values of T between − 60° C. and − 86° C. and finds the condensation coefficient to be 0·94 ± 0·06. Observations by Alty[7] on water drops lead to a condensation coefficient of 0·04 between + 4° C. and − 8° C. If the equation is applied to vaporization from the plane of separation during the first phase of drying (that is, at product-temperatures between − 10° C. and − 30° C.) the mean condensation coefficient is 0·0024. This is equivalent to the statement that the theoretical vaporization-rate, on the assumption of a unit condensation coefficient, is 420 times greater than the experimental value. However, high rates of vaporization may lead to appreciable surface cooling and consequently a greater condensation coefficient. It is also probable that vapour transfer is obstructed by molecular collisions in the tray-condenser interspace. In view of the proportionality between initial volume and drying time, the obstruction to vapour transfer by the layer of partially dry product above the plane of separation is likely to be of secondary importance. The influence of these factors on vapour transfer is under further investigation.

Two freeze-drying plants due to Greaves and Adair[1] and Greaves[2], in which the average length of vapour path is ten times greater than in the tray drier here described, yield average vaporization-rates between 5 and 10 μgm. per sq. cm. per sec. These values are to be compared with the average vaporization-rate of 20 μgm. sq. cm. per sec. given by the tray drier under sterile conditions and a similar product-temperature cycle. It is interesting to observe that curves published by Greaves and Adair[1] for the drying of 5 litres of serum in 100 hr. support the postulation of two phases of drying. These curves show that the first phase of drying required 30 hr. at a product-temperature of about − 20° C. In this time 59 per cent of water had been removed, and on our calculation this is equivalent to a vaporization-rate of 10·9 μgm. per sq. cm. per sec. The average vaporization-rate over the total drying time of 100 hr. was 5·6 μgm. per sq. cm. per sec.

The tray drier was designed three years ago, and, with minor sterile modifications, has been used in the intervening period to dry human fibrin foam[3], human and cow's milk[4], sodium and calcium penicillin solutions, cyst fluid and other biological fluids. An industrial-scale drier based on this design and containing five interleaved tray-condenser units in each vacuum chamber has been erected by Imperial Chemical Industries, Ltd., for the freeze-drying of penicillin solutions.

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Intrinsic Electric Strength of Polythene

THE work of Austen and Pelzer[1] on the use of recessed specimens for measurement of the electric strength of dielectrics suggested that with specimens of this type experimental verification of the theories of breakdown developed by Frohlich and von Hippel[2,3] might be possible. Frohlich's recent extension[4] of his theory predicts: (*a*) that the electric strength should be independent of thickness until the latter approaches the order of the electronic mean free path, when the electric strength should increase with decreasing thickness; and (*b*) that below a certain critical temperature the electric strength should either increase with temperature or be nearly independent of temperature, while above this critical point the electric strength should decrease with increasing temperature according to the relation $\log F \propto \frac{1}{T}$, where F is electric strength and T is absolute temperature.

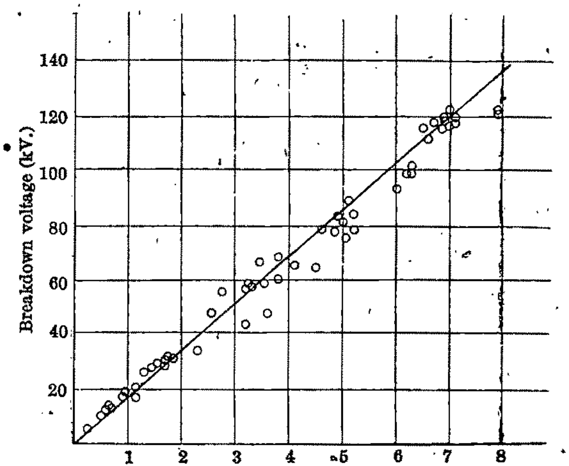

Fig. 1. D.C. BREAKDOWN VOLTAGE OF GRADE 20 POLYTHENE at 20° C.

Recent determinations of the D.C. electric strength of polythene show some measure of agreement with these predictions. For specimens varying in thickness from 0·0005 in. to 0·008 in., the breakdown voltage was observed to be an approximately linear function of thickness (Fig. 1). The mean breakdown stress derived from such a series of measurements was found to be substantially independent of time of application of voltage, radius of curvature of the specimen recess, polarity of the recess electrode, and the nature of the ambient medium. There was a small but significant difference between the value obtained with graphite electrodes and that obtained with silver electrodes, but otherwise it seems reasonable to assume that the mean breakdown stress so measured is an intrinsic property of the dielectric material.

The variation of the breakdown stress of polythene with temperature (Fig. 2) indicates that the critical temperature is about 25° C. The difference in shape between the experimental and theoretical curves is probably associated with the reduction in the crystallinity of polythene with increasing temperature. Frohlich's theory predicts that, as the crystallinity decreases, the critical point will be displaced to a

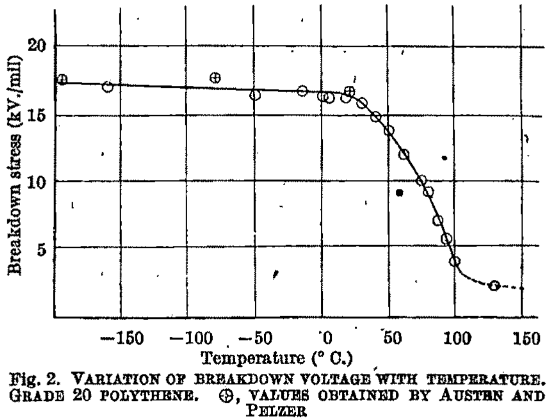

Fig. 2. VARIATION OF BREAKDOWN VOLTAGE WITH TEMPERATURE. GRADE 20 POLYTHENE. ⊕, VALUES OBTAINED BY AUSTEN AND PELZER

lower temperature, and that at temperatures below the critical point the electric strength will increase. Such a displacement of the electric strength temperature curve with decreasing crystallinity may possibly explain the S shape of the experimental curve in Fig. 2.

There is satisfactory agreement between the present results and those obtained by Austen and Pelzer on similar specimens of polythene at 20°, – 80° and – 195° C.

The experimental work involved was carried out in the Electrotechnical Laboratories, University of Manchester.

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Determination of Limit of Proportionality of Wires

In connexion with the determination of the limit of proportionality of cold-drawn wire, the following technique, which so far as we are aware is novel, has been used with success. The wire itself is employed as a 'strain gauge', the increase of electrical resistance as the load is increased being measured. The electrical contacts near the grips of the tensile testing machine were connected to a Cambridge dial bridge on which the resistance was measured; gauge-lengths of 50 or 100 cm. were employed.

Typical curves are shown in Figs. 1 and 2, which refer respectively to mild steel containing 0·08 per cent of carbon and a nickel–copper alloy. In Fig. 1 the elastic range is clearly shown, the curve following very closely that obtained in the normal stress-strain test right up to the point of fracture. Fig. 2 shows the hysteresis loop obtained, both by the normal and the new method.

A point of some interest, for which, as yet, no explanation can be given, is that with some materials a distinct break has been observed in the stress-resistance curve at loads which will carry the material well into the plastic range, a point which is receiving further attention.

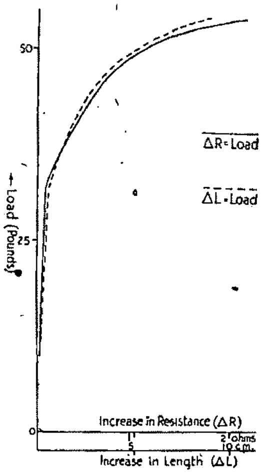

Fig. 1

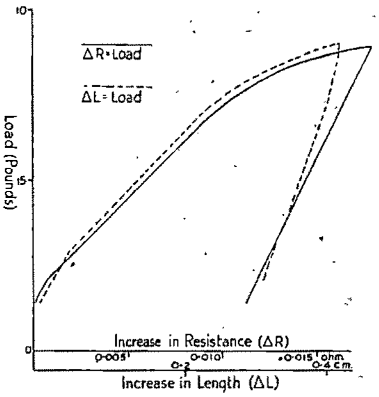

Fig. 2

The simplicity of the new technique, and its ready adaptability to the testing of wire in particular, seemed to justify this short communication.

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The Problem of Classification and Distance Between Two Populations

The problem of specifying an individual as a member of one of many populations, and the classification of a number of populations themselves in some significant system based on the configuration of various characteristics, are of great importance in anthropological and biological research. We may find a collection of skulls with unspecified sexes, and the problem faced by an anthropologist is assigning proper sex to a skull. Judgment based on mere anatomical appreciation of a skull may not be altogether wrong, but is subject to criticism especially when objective methods are available. This problem has been solved by Fisher's *discriminant function*. If we have a collection of skulls grouped according to specified populations, the problem is to arrive at constellations of populations such that any two members of a constellation are closer to one another than any two belonging to different constellations. This problem can be solved by Mahalanobis's *generalized distance*.

In this communication an attempt has been made to present solutions satisfying a logical set of requirements to these problems of classification. The probability distributions considered are quite general and the results arrived at are capable of simple interpretation. Incidentally, this supplies a logical appreciation of intuitive tools introduced by Fisher and Mahalanobis.

Classification with assigned characters in a population. There are two populations π_1 and π_2 characterized by probability densities $f_1(x_1 \ldots x_p ; \theta_1 \ldots \theta_t)$ and $f_2(x_1 \ldots x_p ; \theta_1' \ldots \theta_t')$, where x's are variables and θ's are parameters. We shall denote them by ${}_pf_1$ and ${}_pf_2$, where p stands for the number of characters used, or simply by f_1 and f_2. If an individual can be represented by an ordered set of measurements on p characters or a point in a space of p dimensions, then the problem requires a division of space into mutually exclusive regions R_1 and R_2, and the rule of procedure of assigning the individual to π_1 if he belongs to R_1, and to π_2 otherwise. Let the probabilities of an individual I belonging to R_1 and R_2 when he is from π_2 and π_1 respectively be denoted by

$$P(I \subset R_1/\pi_2) = \alpha_1, \; P(I \subset R_2/\pi_1) = \alpha_2 ;$$

so that these supply the frequencies of errors in classification. If we suppose $\alpha_1 = \alpha_2 = \alpha$, then a logical requirement is that the regions should be chosen such that α is minimum. The problem is solvable by a lemma due to Neyman and Pearson, and the regions are given by $f_1 \geqslant \lambda f_2$ and $f_1 \leqslant \lambda f_2$ respectively, where λ is chosen such that $P(I \subset R_1/\pi_2) = P(I \subset R_2/\pi_1)$, the common value being the minimized value of α.

In some problems, we may require the regions such that $\alpha_1 + \alpha_2$ is minimum, in which case the regions R_1 and R_2 are defined as $f_1 \geqslant f_2$ and $f_1 \leqslant f_2$ respectively; that is, the individual is assigned to one population or the other according to the likelihood ratio of these two hypotheses.

In other problems we may require that α_1 and α_2 should have assigned values smaller than the values obtained above. In this case the space has to be divided into three regions R_1, R_2 and D, such that an individual belonging to D remains unclassified. A logical requirement of the problem, then, is to choose these regions such that the unclassified percentage of individuals in a collection with an unspecified proportion of mixture of members belonging to π_1 and π_2 is minimum. The regions R_1, R_2 and D are given by

$$\frac{f_1}{f_2} \geqslant \lambda_1, \frac{f_1}{f_2} \leqslant \lambda_2 \text{ and } \lambda_2 \leqslant \frac{f_1}{f_2} \leqslant \lambda_1, \text{ respectively,}$$

where λ_1 and λ_2 are chosen such that

$$P(I \subset R_1/\pi_2) = \alpha_1, P(I \subset R_2/\pi_2) = \alpha_2,$$

where α_1 and α_2 are assigned.

In the third case discussed above, the region of doubtful classification has been introduced to keep the wrong classifications at a desired level. If the problem admits the measurement of a large number of characters, we can in some circumstances make the frequencies of doubtful classification as small as possible. A sequential procedure is available, by following which the proportion of wrong classifications is kept at a desired level without making use of a large number of characters. This test has been derived from Wald's sequential theory by suitable extensions to multivariate analysis. Starting with p characters we define the regions ${}_pR_1$, ${}_pR_2$ and ${}_pD$ by

$$\frac{{}_pf_1}{{}_pf_2} \geqslant \frac{1-\alpha_2}{\alpha_1} \; ; \; \frac{{}_pf_1}{{}_pf_2} \leqslant \frac{\alpha_2}{1-\alpha_1} \text{ and}$$

$$\frac{\alpha_2}{1-\alpha_1} < \frac{{}_pf_1}{{}_pf_2} < \frac{1-\alpha_2}{\alpha_1}$$

respectively. If an individual belongs to ${}_pR_1$ or ${}_pR_2$, the conclusions are the same as before. If he belongs to ${}_pD$, we take measurements on *one* or r more characters, and construct these regions corresponding to $p + 1$ or $p + r$, and so on. The details of this test have been worked out in the case of multivariate populations of the normal type, and will be given elsewhere.

Distance between two populations. If we have a mixture of individuals belonging to π_1 and π_2 in equal proportion, then following the two procedures given above, the proportions of correct classifications are $1-\alpha$ and $1 - \frac{\alpha_1+\alpha_2}{2}$. We may take the first or the second as the distance between two populations π_1 and π_2. These are capable of simple interpretation, as α and $(\alpha_1+\alpha_2)/2$ stand for overlapping individuals who may be wrongly classified. It is interesting to observe that the distances defined by the above expressions obey the triangle law, namely, the sum of distances of a population from two different populations is not less than the distance between the two other populations. The distances defined are explicit functions of Mahalanobis's D^2 in the case of multivariate normal populations.

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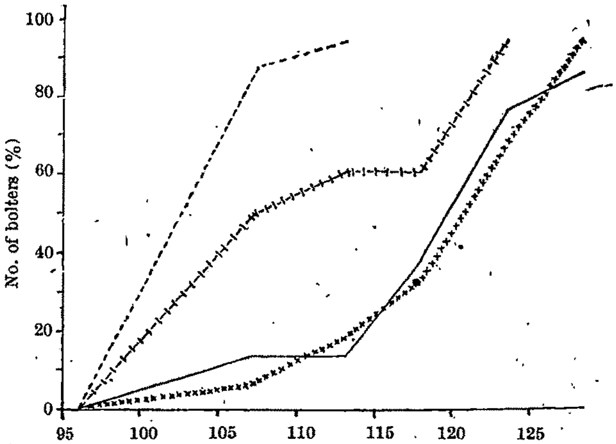
Oct. 17.

Vernalization of Lettuce

Gray[1] and Simpson[2] have both reported experiments on the vernalization of lettuce, and these observers agree that low (2–8°) temperature treatment of the swollen seeds for varying periods, while not affecting the date of heading, reduces the period for which the plants remain in the heated stage and accelerates flowering by fourteen to twenty days. Experiments carried out here indicate the importance of the timing of these vernalization treatments.

Four sets of Feltham King lettuce (a long-standing variety of summer cabbage lettuce) were sown outdoors on April 8. One set of seed (S) was soaked for twenty-four hours before sowing, and a second set (SX) for seventy-two hours, by which time germination had begun and the radicles emerged. Two other sets (V and VX) were similarly soaked, and after soaking held at 0–4° C. for twenty-four days before sowing. All four sets were sown together, all germinated and emerged from the soil satisfactorily and at apparently the same rate, and came to the hearting stage together. They showed, however, considerable differences in the rate at which 'bolting' occurred. In no set was any sign of bolting evident before July 20, and the percentage of bolters in each set after this date is shown graphically below.



Vernalization of lettuce: graphs continued to maximum values obtained

– – –, V ; —I—I—I, VX ; ——, S ; x x x, SX

That 100 per cent of bolters were never found was due to a small attack of *Botrytis cinerea*. The difference in appearance of the four sets of plants was most striking on July 30. On this date the majority of *V* plants were 45–60 cm. in height, and the *VX* plants 15–18 cm., while a few *S* and *SX* plants were just showing only the first signs of 'bolting'. Actual flowering dates were for the *V* plants Aug. 28, *VX* plants Sept. 2 and *S* and *SX* plants Oct. 1. The vernalization treatment of the swollen seed accelerated flowering by thirty-one days. This great acceleration was probably due in part to unfavourable weather during September, retarding the flowering of the *S* and *SX* plants. The chief point of interest is that the vernalization treatment given after radicle emergence had occurred was so much less effective than the treatment commenced after the seed had swollen for only twenty-four hours and before germination had begun.

A rather severe attack of *Botrytis* on a similar series of Webb's Wonderful lettuce was not sufficient to mask similar trends with this variety.

These observations serve to emphasize the importance of the timing of any vernalization treatments. They may not be without their practical significance. Early sowings of a number of crop plants (for example, beet, turnip, celery[3,4], etc.) are especially prone to flower prematurely, and this may be due in some cases[4] to a vernalizing effect on the swollen or germinated seed, or on the seedlings, of naturally experienced low soil or atmospheric temperatures in early spring. In so far as the effect is one on the swollen seed and not on the young seedling, the possibility of avoiding these undesirable effects by the sowing of already germinated seed is opened up.

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Nov. 28.

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Prevention of Oil Shock in the Orchard

THE use of a highly refined petroleum oil for application to orchard trees as an insecticide and acaricide is firmly established as a valuable pest-control treatment with citrus, but its use on deciduous trees in summer is limited by the fact that, under certain ill-defined conditions, severe leaf and fruit-drop has been known to occur following the use of a 'summer' petroleum spray.

During the seasons 1944, 1945, 1946, we have carried out field experiments in commercial apple orchards designed to determine whether the addition of the plant-growth regulator alpha naphthyl acetic acid to a white-oil spray would prevent the leaf- and fruit-drop which might otherwise be induced. Until this season we failed to produce leaf- or fruit-drop by the application of oil in trials in Kent, Sussex and Essex; but this year, on a farm in Essex, severe drop of both leaves and apples did occur in the case of the variety Cox's Orange Pippin after spraying with a white-oil emulsion used at 1 per cent (0·75 per cent actual oil). The base oil conformed to the official specification for horticultural white oils for orchard use. On adjoining plots alpha naphthyl acetic acid was added to the diluted oil emulsion as sprayed, so that the concentration of the plant-growth regulating substance was 10 parts per million. The spraying was carried out on June 19, 1946, the variety being Cox's Orange Pippin with Worcester Pearmain as pollinator. On August 28, 1946, a count of the fruits remaining on the Cox trees was made, and the average fruits per tree were as follows:

Control—unsprayed trees	44·2
White-oil spray alone	6·0
White-oil spray plus alpha naphthyl acetic acid	51·9

In this case, therefore, the alpha naphthyl acetic acid, a material which is commonly used for the prevention of pre-harvest drop of apples and pears, applied simultaneously with an oil spray, has modified or prevented the shock due to the application of oil and thereby prevented leaf- and fruit-drop.

We regard this result as important since a summer application of white oil to foliage is probably the best method of controlling the serious pest red spider mite (*Oligonychus ulmi* C. L. Koch) on apples, and hitherto oil has not been widely used for this purpose in Great Britain because of the risk of causing leaf- and fruit-drop.

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Gaseous Sulphur Dioxide and Sodium Bisulphite as Preservatives of Citrus Concentrates

DIFFERENTIAL preservative efficiency between gaseous sulphur dioxide and sodium bisulphite, observed in citrus concentrates, became of practical significance during the War due to the difficulties in obtaining an adequate supply of gaseous sulphur dioxide in Palestine. Investigating the effect of acidity on the efficiency of various preservatives, Rahn and Conn[1] found that yeast is checked only by molecular H_2SO_3, and not by dissociated ions HSO_3' or SO_3''. According to Downer[2], quantities ranging between 2,000 and 2,500 p.p.m. sulphur dioxide are necessary for citrus juice concentrates (4 : 1), and even more are required for higher concentrations, in order to prevent fermentation. This has been explained by him as due to the fact that part of the sulphur dioxide combines with the aldehyde group of the sugar contained in the juice, leaving only part free to act as preservative.

In our experiments, increasing amounts of sodium bisulphite and parallel gaseous sulphur dioxide have been added to concentrated citrus juice (6 : 1), inoculated with a known number of wine yeast. The test mixtures, which have been examined periodically during three months, showed the bisulphite to be at least 30–40 per cent more efficient than sulphur dioxide.

The minimum quantity of sodium bisulphite to be added to the concentrate, in order to prevent fermentation, has been found by us to range between 1,000 and 1,200 p.p.m., equivalent to 600–700 p.p.m. sulphur dioxide, while 800–1,000 p.p.m. gaseous sulphur dioxide, equivalent to 1,300–1,600 p.p.m. bisulphite, are necessary to produce the same effect.

No significant difference has been observed in the *p*H of citrus juice concentrate containing either of the two preservatives. Both of them also show the same vitamin C content.

It is to be noted that tests with 1,000 p.p.m. sulphur dioxide gas (or 1,300 p.p.m. sodium bisulphite), and more, preserved the original colour almost to the very end of the experiment (more than three months), the test being carried out at 25–28° C. Control tests and citrus concentrates containing less than 1,000 p.p.m. sulphur dioxide darkened progressively with storage.

It seems to us that larger amounts of preservatives are required for colour preservation than for microbiological protection. The limit for the former has been found to be 1,000–1,200 p.p.m. sulphur dioxide gas, or 1,200–1,350 p.p.m. bisulphite solution (equivalent to 700 p.p.m. sulphur dioxide).

The relative efficiency of gaseous sulphur dioxide and sodium bisulphite solution may be explained by the different behaviour of the two forms of preservatives when dissolved in the citrus juice concentrate[3].

These experiments have been carried out in the Department of Biological and Colloidal Chemistry, Hebrew University, Jerusalem, with the generous co-operation of Prof. A. Fodor, director of the Department. We acknowledge with thanks the interest taken by the Scientific Advisory Committee, War Supply Board, Government of Palestine, which has also sponsored this investigation.

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Vitamin Content of Tubercle Bacilli

MANY chemical compounds which inhibit the growth of certain bacteria are structurally related to compounds which are growth stimulators for the same bacteria. This relationship makes of interest the vitamin content of pathogenic bacteria grown on vitamin-free media, since this may give a clue to the structure of compounds which are important in the metabolism of the micro-organism under study and indicate a starting point for the synthesis of possible growth inhibitors. Thus, Ekstrand and Sjögren have reported on the production of *p*-aminobenzoic acid by the tubercle bacillus[1].

Recently we have had occasion to assay a tubercle bacillus culture for several vitamins by microbiological methods. The culture was an H37Rv strain of virulent human type tubercle bacilli (supplied by Dr. Guy P. Youmans, Northwestern University Medical School, Chicago) which had been grown for 21 days on Proskauer – Beck medium. Determinations were made on the carefully suspended whole culture and on the clear filtrate after removing bacterial cells by centrifugation. The results are indicated in the table.

Vitamins determined	Culture filtrate* (γ/c.c.)	Whole culture† (γ/c.c.)
Vitamin Bc	0·05	—
p-Aminobenzoic acid	—	0·0216
Pantothenic acid	1·04	—
Riboflavin	0·2	1·5
Nicotinic acid	37	61
Biotin	0·03	0·057

* Autoclaved 30 min. at 15 lb. pressure before assaying.

† Autoclaved 30 min. at 15 lb. pressure in *N* sulphuric acid before assaying.

A sample of the basal medium was also assayed for the vitamins indicated. Negative results, indicating less than 0·002 γ per c.c., were obtained for all except nicotinic acid. The amount of nicotinic acid found was 0·071 γ per c.c.

Of interest in these results are the rather high content of nicotinic acid and the low content of vitamin Bc and *p*-aminobenzoic acid. Ekstrand and Sjögren[1], using a chemical method of assay, also found only a small amount of *p*-aminobenzoic acid in tubercle bacilli. This is in contrast to a value of 0·63 γ *p*-aminobenzoic acid per c.c. which we recently obtained for a 17-hr. culture of *E. coli*.

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Antibacterial Titre in Wood-destroying Fungi

FROM exploratory surveys of the production of bacteriostatic substances by wood-rotting fungi both in Great Britain and in the United States, it appears that the authors, Wilkins[1] and Robbins *et al.*[2], have tested the antibacterial activity of the metabolism-solution periodically up to a maximum of 30 days and 22 days respectively, and that their test-organisms have always been *Bacterium coli* and *Staphylococcus aureus*. On the basis of my experiences stated below, I suggest that: (1) this period of test should be extended, and that (2) some other organisms should also be employed as test-organisms from time to time.

In the course of my work on the antibacterial activity of 'polyporin' from a wood-destroying fungus, *Polystictus sanguineus*, I[3] have observed that the antibacterial titre persists for a much longer time (in some cases more than three months), with periodic rise and fall of the titre, and that the activity which appears very early in the course of a week or so goes down soon and does not seem so stable as the one which appears later. For example, in an inoculated flask where the composition of the medium was of $MnSO_4$, $FeSO_4$, pea seed-extract, KH_2PO_4 and 4 per cent glucose, the antibacterial activity of the fungus which appeared on the ninth day disappeared on the eleventh, while the activity appearing on the fifteenth day continued until the thirtieth, and the activity reappearing on the sixty-fifth day continued until the eighty-sixth; in another case I have a record of continuing activity from the seventieth to the ninety-eighth day, with five rises and falls from the initial start. Kent[4] has distinguished two kinds of substances in the metabolism solution, one as staling substances which appear earlier in the course of growth of the organism and are not very stable, and the other as inhibitors which are fairly stable and are slow in appearing in culture media. It has been further observed that a fungus inactive against *Staph. aureus* and *B. coli* forms substances antibiotic against other organisms (typhoid, cholera, etc.).

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Sex in *Melandrium*

THE development of stamens in pistillate plants of *Melandrium* under the influence of *Ustilago violacea* (Pers.) Fuckel is well known. Recently, this action has been simulated by treatment of plants with the animal hormone testosterone, while the reverse change has been caused by œstrone[1,2]. None of the authors responsible for accounts of the reversal, whether natural or artificial, has remarked upon the fact that, when such a change from the pistillate to the staminate condition occurs, some characters of pistillate plants are replaced by those typical of staminate plants while others are not. Thus, the copious branching and diminution in size of the leaves which is produced in the region of the inflorescence, and the grouping of the flowers into more or less sessile clusters, all of which are characteristics of staminate plants, appear after infection. On the other hand, the calyx retains the inflated shape characteristic of pistillate plants and, although infection of originally pistillate and staminate plants reduces the length of the calyx-teeth, they retain the characteristic difference in shape, and those of the pistillate plants remain the longer. These characters are seen best in *M. album*, where the differences between pistillate and staminate plants are more extreme.

It appears that the differences in branching are secondary sexual characters while the differences in calyx-characters are completely sex-linked. One of the purposes of this note is to indicate the possibilities which such hormone studies hold out in discriminating between two otherwise inseparable types of character.

Infection by *Ustilago violacea* or, according to Löve and Löve[1,2], the application of the *single* chemical substance testosterone, can perform the *dual* function of promoting the formation of stamens and suppressing the formation of pistils. On the other hand, Westergaard[3,4] has postulated that these two functions are performed, normally, by two separate sets of genes on the Y-chromosome, and has produced considerable cytological and genetical evidence in support of this idea, including the removal of the 'female-suppressors', in which case the plants lacking them produce both stamens and pistils.

One modern tendency (see review by Löve and Löve[2]) is towards the assumption that the normal formation of staminate flowers is due to the genically controlled production of a substance resembling testosterone. This does not preclude the possibility of the simultaneous production of 'œstrone' in quantities insufficient to affect the morphology. It is not easy to reconcile this view with the *two specific* actions which Westergaard postulates for the sets of genes. This difficulty is important because Westergaard has made far-reaching deductions concerning the evolution of diœcism from his results.

It should be pointed out, however, that in interpreting the genetical data the idea of 'female-suppressors' in *Melandrium* has been introduced only because the effect of the *removal* of the genes concerned is to cause pistil development. Alternatively, it might be argued that a concentration of 'testosterone' just sufficient to promote the formation of stamens but insufficient to suppress pistil-formation might be produced under the influence of one set of genes, while an additional production of 'testosterone' caused by the other set of genes would induce the abortion of the pistil. Thus, the two sets of genes could have the same action and neither be specifically a 'female-suppressor' nor a 'male-promoter'. This view is supported by the fact that purely pistillate plants, when infected by *Ustilago violacea*, produce well-formed stamens, while the abortion of the pistil varies in extent and is never complete. A similar impression is gained from the diagrams by Löve and Löve[2] showing the effect of treating pistillate plants with testosterone.

In *Melandrium* the structure of the X-chromosome is not so well known as that of the Y, so that 'male-suppressors' or 'female-promoters' upon it are not known as yet.

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Sweating in Sheep

DURING investigations on the humidity of the fleece atmosphere carried out in the summer of 1946, certain sheep were found to have a consistently higher relative humidity (70–90 per cent) close to the skin than at points farther out in the thickness of the fleece (25–50 per cent); humidity measurements being made with cobalt chloride papers, prepared as described by Solomon[1]. Strips of cobalt chloride paper were placed vertically in the fleece so that one end of each strip rested on the skin and the other lay about 1 in. away from the skin. Humidity differences were measured between the two ends of single papers so placed. In one healthy, undipped sheep, the high humidity found at the base of the fleece was confirmed by placing close to the skin *Lucilia sericata* (Mg.) eggs incubated to within half an hour of hatching; other eggs from the same batch were placed in the same part of the fleece, but one inch away from the skin. The eggs near the skin hatched immediately, indicating a humidity of at least 80 per cent, as shown by the work of Davies and Hobson[2]. The larvæ survived in this position and established a strike without any addition of moisture. Eggs placed one inch from the skin did not hatch, indicating a lower humidity at that point. The limiting factor for strike on this and other sheep used appeared to be the non-attraction of blowflies to oviposit on them. The existence of a population of gravid blowflies in the vicinity was shown by attracting flies to oviposit on some of the sheep, using the technique of Hobson[3].

It is concluded from the above evidence that certain sheep sweat to an extent sufficient to maintain humidities at the base of the fleece suitable for the development and survival of blowfly eggs and young larvæ. Under similar weather conditions, other sheep were found to have fleeces too dry throughout for strikes to develop successfully.

It was not clear from the above observations how far such sweating varied and depended on the activity of the sheep. Freney[4] attempted to find if sweating occurred in sheep after running; he found that the weight of moisture in wool samples from the base of the fleece did not increase after sheep had been run in hot weather. The following experiments were made, therefore, using cobalt chloride papers as described above, to discover how far moisture conditions at the base of the fleece depended on activity. The accompanying table gives readings of fleece atmosphere humidity for a single dry-fleeced Herdwick × Swaledale wether, 18 months old, before and after running for 10 minutes around a field on a sunny afternoon in August 1946 (air temperature, 16° C.).

% R.H. FLEECE ATMOSPHERE, AS MEASURED BY COBALT CHLORIDE PAPERS
(Papers reading 20–40% R.H. were not accurately read, but are recorded as 'below 40%')

Position in the fleece	15 min. before running		30 min. after running		2 hours after running	
	Skin surface	1 in. off the skin	Skin surface	1 in. off the skin	Skin surface	1 in. off the skin
Withers	below 40	below 40	55	48	below 40	below 40
Tailhead	below 40	below 40	57	—	below 40	—
R. crutch.	below 40	below 40	62	62	45	—

It is seen that after the sheep was run the relative humidity at the base of the fleece rose, clearly indicating that an increased rate of sweating had occurred. Further, the fall in humidity after two hours indicates that the effect was transitory. The experiment was repeated four times on the same sheep on different days with similar results. A single experiment on a Swaledale ram lamb also showed a transitory rise in basal fleece humidity after running.

The full results of fleece humidity measurements by cobalt chloride papers will be published elsewhere.

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Nov. 26.

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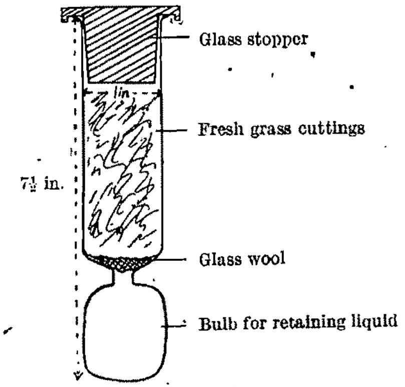
Activity of Thermophilic Bacteria in Composts of Fresh Green Material

DURING the course of an investigation on the microbiology of composts made from fresh grass cuttings, it was noticed that a dark brown liquid oozed from the material. A large volume of this liquid is produced, and it is very rich in ammonia nitrogen. Under normal conditions of composting it would be lost, and therefore some knowledge of its production is of considerable interest. The liquid first appears when the compost is at a temperature of 65°–55° C.

It has been found possible to reproduce the above phenomenon on a small scale in the laboratory. The arrangement illustrated has proved particularly satisfactory. Series of these tubes can be incubated in a thermostatically controlled water-bath at 65° and 55° C. From the results of experiments with these tubes, it is suggested that this dark brown liquid may be formed through the degradation of organic nitrogen to ammonia by thermophilic bacteria, and the subsequent hydrolysis of chlorophyll under the alkaline conditions produced by this ammonia.

At the temperatures mentioned above, a thermophilic bacterial flora has been found to develop both in the compost and in the tubes. In the compost it can be seen as a white coating covering the cuttings, particularly in the upper layers. Also the dark-coloured liquid produced in the compost and in the laboratory experiment is in both cases very rich in thermophilic bacteria. It was thought that there might be some relationship between the activity of the thermophilic flora and the production of the liquid. The following evidence supports this view.



(*a*) Fresh grass cuttings sterilized with 1/1,000 corrosive sublimate when incubated for five days at 65° C., followed by eight days at 55° C., failed to produce the typical dark brown liquid. The grass also retained its green colour and showed no evidence of decomposition.

(*b*) Unsterilized fresh cuttings under the same conditions of incubation gave the liquid, the grass changing its colour from green to brown, and obviously undergoing decomposition.

(*c*) Many isolates of the thermophilic flora have been made from both the compost and the tubes. True and facultative thermophilic bacteria have been found to be present. They are rod-shaped, spore-forming bacilli and are very strong ammonifiers. They do not attack chlorophyll in culture media.

(*d*) Chemical analyses have shown a marked increase in ammonia nitrogen when fresh grass is incubated at 65° C. This does not occur when the cuttings have been sterilized.

It would appear, therefore, that the thermophilic flora attacks organic nitrogenous material of the compost, liberating ammonia. As a result of this, it would be expected that conditions in the tubes and compost would become alkaline. Measurement of *p*H shows this to be the case.

It is well known that chlorophyll can undergo changes from green to brown when hydrolysed under alkaline conditions. In view of this, it seemed possible that the explanation of the dark brown colour might be connected with the production of alkaline conditions. Moreover, the thermophilic bacteria isolated did not attack chlorophyll in culture media.

The following experiment supports this hypothesis. Tubes with sterilized grass were set up, and into the bulb of each tube a few c.c. of strong ammonium hydroxide were introduced. The tubes were then incubated at 65° C. In a few days the grass began to change from green to brown, and the liquid which collected in the bulbs was very similar in appearance to that produced during composting.

Full details and further information on the microbiology of grass composting will be published in due course.

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APPLICATION OF STATISTICAL METHODS TO FOOD PROBLEMS

STATISTICAL analysis and the logic of inductive inference are taking a part of increasing importance in many branches of scientific research and technology. Evidence of this is provided by the wide range of scientific journals and meetings in which there is frequent discussion of points of statistical technique. A few years ago, the statistical aspect of problems under consideration at scientific meetings was seldom mentioned; to-day there is a welcome tendency for societies to keep their members informed of developments in statistical methodology important to their field of study. At a well-attended joint meeting of the Society of Public Analysts and Other Analytical Chemists and of the Food Group of the Society of Chemical Industry, held on December 4, papers on "The Application of Statistical Methods to Food Problems" were read and discussed. The president of the Society of Public Analysts, Dr. G. W. Monier-Williams, was in the chair.

An introductory paper, "The Inevitability of Statistics", was given by Mr. D. J. Finney (University of Oxford). He said that since many types of measurement, in the physical as well as in the biological sciences, are not perfectly reproducible in repeated trials, the interpretation of numerical data is often impossible without using, explicitly or implicitly, statistical concepts. Even the calculation of a mean of several observations is a statistical operation, and from the dispersion among individual values the reliance to be placed on the mean may be assessed. A chemist should therefore have some knowledge of statistical principles, even though he need not concern himself directly with the computation of statistical analyses. Mr. Finney asked for close co-operation between analytical chemists and statisticians in the planning of investigations, as well as in the examination of results, since this would tend to increase the information obtainable from a specified amount of experimental work. He instanced the sampling of foodstuffs for the estimation of a constituent, including quality control with the aid of routine sampling, the design and analysis of experimental work in food production and in laboratory testing, and biological assay, as examples of the many ways in which statistical science can help in the elucidation of food problems.

Mr. W. B. Adam (Fruit and Vegetable Preservation Research Station, Campden) spoke on "The Use of Statistical Methods in Research on Food Canning". He emphasized the need for good experimental design and sound statistical technique in research into food technology; since the raw materials are very variable in composition, the relative effects of different treatments can be estimated from a reasonable amount of experimentation only if statistical science is exploited to the full. He then briefly described a number of problems from his own experience in which statistical methods had been of great assistance, and gave numerical results from typical experiments. Simple *t*-tests had been found useful in studies as varied as an inquiry into the effects of surface treatment and abrasion on the corrosion-rate of tinplate, and tests of the control of 'gumming' in plums by boric acid treatment of trees. In an investigation of the extent to which sulphur, phosphorus and copper in tinplate influence the formation of 'hydrogen-swells' during the storage of canned fruit, correlation and regression methods had been used for examining the inter-relationships of the many factors. Correlation methods had also shown a close association between seasonal rainfall and gum production in plums. Analysis of variance had been particularly valuable for data from field and orchard trials, such as those concerned with spraying for disease control. Mr. Adam pointed out that statistical analysis assists the critical appreciation of data, but should never be regarded as a substitute for accurate chemical analysis.

A paper by Dr. K. L. Blaxter (Ministry of Agriculture and Fisheries Veterinary Laboratory) on "The Evaluation of the Nutritive Value of Animal Feeding-Stuffs" was read by Dr. Allcroft. Dr. Blaxter stressed the great variation found in the constitution of feeding stuffs, in the ability of individual animals to utilize their food, and in the requirements of individuals for different nutrients. He mentioned the possibility of controlling animal variation by the selection of homogeneous groups for experimentation; this is less easy for farm animals than for small laboratory animals, but even where it is possible it may have disadvantages in limiting the applicability of conclusions. By careful planning (which must not be thought an excuse for shoddy experimental technique), a factorial design permitting the estimation of components of variation from different sources may be chosen. The measuring of variation is complementary, not antagonistic, to its minimizing; by its aid is obtained a wider basis for inductive reasoning from the results. He had found change-over designs, in which each animal receives each diet for some period of the experiment, to be capable of measuring comparatively small treatment-effects with precision, and yet to give data for estimating effects under a variety of conditions. Often herds may respond differently to treatment-variants, so that unless experiments are replicated over several herds there can be no assessment of the consistency of treatment-effects. The experimenter's ideal should be to discover the mechanisms of cause and effect underlying all variation. Until that knowledge was attained, Dr. Blaxter considered efficient experimental design and the reduction of the results by the best statistical techniques to be essential in the study of the complex problems of animal nutrition.

Mr. E. H. Steiner (British Food Manufacturers' Research Association), in a paper entitled "Application of Statistical Methods in Calculating Proportions of Ingredients in Certain Food Products", discussed a more specialized problem. He showed how knowledge of the natural variations in the composition of food ingredients can be used, in conjunction with the results of analysing a sample of a compound food, so as to provide an estimate of the range within which the proportion of a particular ingredient is likely to lie; an arbitrary standard of probability has to be chosen, and is usually 95 per cent. Mr. Steiner then gave tables showing limits of error under specified conditions of variability in the ingredients, and described how allowance can be made for the experimental error of analysis. He mentioned the application of this method to the estimation of meat in pork sausages, in which cereals also contribute to the protein content, and the proportion of animal protein has to be obtained. By widening the limits of error, the chance that a product is wrongly condemned is reduced; but, on the other hand, products below standard are then more likely to escape condemnation.

These papers provoked a spirited discussion. Mr. P. Lyle spoke of a rapid method for estimating the mean and standard deviation of a normal distribution from a table of frequencies. If a table of cumulative frequencies is formed, and the corresponding ratios plotted on specially ruled probability paper, the resulting points will lie approximately on a straight line; the 50 per cent value of this line gives the mean of the distribution, and the reciprocal of its slope is the standard deviation. He said that he had generally found methods of regression analysis to give a more readily understandable representation of results than the calculation of correlation coefficients. From a slightly different point of view, this matter was also raised by Mr. Clayson, who criticized the correlation between rainfall and percentage 'gumming' quoted by Mr. Adam; he said that since 'gumming' was caused by bacterial infection of the trees, no meaning could be given to the rainfall correlation. In reply, Mr. Adam stated that not all 'gumming' could be attributed solely to bacterial causes; he and other speakers also pointed out that the existence of a correlation does not imply a direct causal relationship, but may be due to the two variates being to some extent dependent upon common causes. Mr. Leibmann mentioned the danger of drawing misleading conclusions from spurious correlations.

Dr. J. G. A. Griffiths questioned the practice of using a normal frequency distribution to represent the distribution of a measurement the range of variation of which is not infinite. He was particularly concerned about the probabilities of extreme values, and described the difficulty of using a statement of probability as the basis for legal action concerning the constitution of a food product; the assertion that a sample analysed had only a very small probability of occurrence in random sampling from a product that was up to standard might be countered in court by the claim that a rare chance could occasionally happen. He would prefer to argue on impossibility rather than on low probability, and would therefore like to make use of a distribution with finite range. Mr. Finney replied that even though a measurement is known not to be able to take an infinite range of values, the satisfactory determination of the extremes is not easy. For many purposes the normal distribution has been found a sufficiently good approximation, as the true limits of the distribution are so wide that even the assumption of normality allows an exceedingly small probability of their being surpassed. Furthermore, it can be demonstrated that the distribution of a mean of several observations will generally be much closer to normality than that of a single observation, and usually decisions will be taken only on mean values. He stated that the statistician would use other forms of distribution function when these are found to be more appropriate, but that often it is impracticable to obtain positive evidence of any other distribution fitting the material more closely than the normal. Mr. A. L. Bacharach suggested that a statement of the analyst's experience that "a value so extreme has never been found for a product *known* to be of satisfactory quality" would often be a more effective way of presenting evidence than a quotation of probability levels. Mr. E. C. Wood reminded the meeting that the choice of 5 per cent significance level is arbitrary, and that, for the purpose of an action at law, a more stringent criterion might be desirable.

Dr. Nicholls inquired about the possibility of combining evidence that a product is below standard; statistical analyses of sample determinations of two or more different constituents might show each to be below standard, though not significantly so, and a composite test would be needed in order to summarize the weight of evidence against the product. Mr. Steiner suggested that a combined index might be formed which would be more sensitive to discrepancies than any one of the measurements used in forming it. Mr. Wood mentioned the use of discriminant functions.

Mr. Wood emphasized that the statistical analysis of data need not require a great amount of tedious calculation. Often a simple preliminary examination of the figures will readily indicate the answers to all the main questions, and no complete analysis will then be needed; this is particularly likely when efficient experimental designs are used. Occasionally the full analysis might mean all the difference between obtaining unreliable, or even misleading, information from an experiment, and obtaining a sound and detailed interpretation of the data; in an investigation for which the experimental work had taken a much longer time, a few hours of computing might be a small price to pay for valid conclusions.

As a simple example of the planning of experimentation, Mr. Wood said that the practice of combining a number of independent samples of a product into a single bulk, from which duplicate sub-samples are drawn for chemical analysis, leads only to an estimation of analytical variations; if, instead, the original samples are combined into two bulks, from each of which a single sub-sample is drawn, the difference between the sub-samples also estimates the true sampling variability of the product.

Mr. K. A. Brownlee spoke of the importance of ensuring that so-called 'duplicate' analyses are really based upon repetition of all the analyst's procedure, and are not merely obtained by simultaneous parallel chemical analyses of two sub-samples under practically identical conditions; for many purposes the co-operation of different workers, and even of different laboratories, is necessary if the true variability of an analytical technique is to be assessed.

D. J. FINNEY

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE sixty-fifth meeting of the French Association for the Advancement of Science was held at Nice during September 9–14, 1946, under the presidency of Prof. Paul Montel. The opening meeting was held in the great hall of the Centre Universitaire Méditerranéen, which had been placed at the disposal of the Congress, and served as the general headquarters. Speeches of welcome were made by the Préfet of the Alpes Maritimes, the Mayor of Nice, and by Prof. Mario Roques, who pointed out that although Nice had the reputation of being a town of pleasure, it was also a town for meditation and study. Then followed addresses by representatives of the foreign delegates to the Congress, including H. Munro Fox (Britain), de Selys-Longchamps (Belgium), Wavre (Switzerland), Burgers (Holland), Bydzovsky (Czechoslovakia), Sergescu (Rumania), and Kepinski (Poland). Finally, Prof. Montel delivered his presidential address on the role of mathematics in the ordinary life of individuals.

The afternoon was devoted to certain inter-sectional meetings at the Centre Universitaire, and the organisation of sectional programmes at the Lycée de Garçons which had just been rebuilt. Tuesday, Wednesday and Friday were occupied mainly by the work of the sections, but the proverbial hospitality of Nice was shown in the variety of entertainments arranged by the municipality, including a reception at the Villa Masséna and a concert at the Opéra. Thursday was devoted to an excursion to Monaco, including visits *en route* to the Mont Gros observatory and the famous Augustus Monument and Museum at La Turbie.

At Monaco the afternoon was spent at the Oceanographical Institute, where the Director, Commandant Rouch, gave an account of the work of the Institute. Afterwards a visit was paid to the Jardins Exotiques with their extensive collection of cacti and other xerophytes.

Saturday, the last day of the Congress, concluded with an address by Commandant Rouch on French oceanographers, from Pythéas to Charcot; he recalled that it was exactly ten years since the *Pourquoi Pas* disappeared with Charcot and his crew.

A special feature of the Congress was the number of papers dealing with local problems, and excursions were arranged by many of the sections, including those of geology, botany, biogeography, agronomy and forestry. There was, for example, a valuable day excursion in motor coaches ascending the mountains inland from Nice to a height of 1,700 metres to view the successive altitudinal zones of the forests (at a number of places the excursionists were not allowed to walk off the road owing to unexploded mines).

The Congress was attended by many foreign delegates and also by representatives of more than forty French academies and scientific societies. The British Association was represented by Dr. Edward Hindle, one of its general secretaries, and Prof. H. Munro Fox.

It was decided to hold the Congress for 1947 at Biarritz towards the end of September. Dr. L. Fage, professor at the National Museum of Natural History, was elected president, and Dr. Lavier, professor at the Faculty of Medicine, Paris, was appointed secretary.

E. HINDLE

GROWTH OF MODERN PSYCHIATRY*

IN his three Salmon Memorial Lectures before the New York Academy of Medicine, Dr. D. M. Levy traced the growth of modern psychiatry and showed its influence on psychiatric thought. Dr. Levy commenced his career in the Illinois Institute for Juvenile Research in 1920. The study of delinquency was then very much under the influence of the work of Dr. William Healy, and was beginning to be applied to criminology. Healy himself was building upon the foundations laid by Meyer, Binet and Freud. Meyer had developed the view that behaviour is a reaction to environment, and under him psychiatry became the study of purpose and response. Binet had opened the way to the measurement of mental powers by his work on school-children, and Freud had stripped away illusions to show the real motivation behind conduct. The result of their impact upon Healy was his book, "Mental Conflict and Misconduct".

Dr. Levy showed the development of child guidance and demonstrated it by an interesting recital of a case which attended the clinic where he then worked. The different approaches to the child's problem were studied with earnestness and enthusiasm, so that one feels, as he said, that these were exciting days and even the smallest discovery was fascinating. He showed how the environmentalist exploited milieu psychology and the impact of social forces upon the child's behaviour; the psychometric testing revealed the individual's intellectual capacities, and the organic approach showed underlying physical disease. Although all these were rival methods, and to some extent still are, they have been integrated into teamwork which reveals the whole. Yet in spite of all its advances, child psychiatry is still in a formative phase.

In his second lecture, Dr. Levy discussed delinquency, and pointed out that here, on the whole, psychiatry has not made notable progress. This is partly because of the legal difficulties and the lack of institutions suitable to exploit the psychiatrist's recommendations.

Psychotherapy may be useful for the criminal, but it is prolonged, and an impractical treatment with present resources. The correction of environment is helpful, and group psychotherapy offers promise. Foster homes are useful in certain cases. When institutions are used, every member of the staff should have an understanding, non-authoritarian attitude. Delinquent children previously exposed to disciplinary measures are confused when they breathe this new air. They suspect trickery, try to discover the weak spots, attempt to escape or run amok. Finally they settle down and the remedial aspects of the new method appear.

Dr. Levy traced the gradual advances from dungeon to prison, from prison to reformatory, and showed that this was an evolution of society's attitude to the criminal from primitive vengeance, graded punishment according to the seriousness of the offence, then the acceptance of some responsibility for the delinquent behaviour, and at last to the attempt to reform him. Modern psychiatry regards crime as something curable, something from which the criminal suffers. Reform in Britain has progressed farther than in the United States, but America leads in psychiatric study and treatment. He deplored the fact that psychiatry is so often neglected, and pointed out that many penitentiaries still have no psychiatric service.

Dr. Levy discussed the inroads which lay-psychotherapists are making into psychiatry; he fears that they will cause a permanent lowering of standards.

In his last lecture, Dr. Levy demonstrated that psychiatry is progressing through various phases. At first the psychiatrist dealt only with the severe neuroses and psychoses. Then he tended to be consulted regarding personal problems by labour and management. The third phase would be an integration with industry, but it remains a remote possibility. He gave various interesting points regarding the relationship between foremen and workers. These have shown a gradual transition in behaviour. The first and most primitive type of relationship was when the foreman gave an order categorically. Dr. Levy called this authoritarian. A further step was when the foreman gave an order and explained the reason for it. This he designated transitional. Finally, when the foreman consulted the worker, asking for criticism and advice, this was a participating relationship. The older the factory and the closer the union between foreman and worker, the more the relationship tends to be a participating one.

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* Substance of the Salmon Memorial Lectures delivered at the New York Academy of Medicine by Dr. David Mordecai Levy, director of the Information Control, Division Screening Centre, U.S. Army, Germany, on November 6, 13 and 20.

Dr. Levy then turned to military psychiatry. This served its apprenticeship in the First World War, and in the Second World War was used much more extensively. Greater reliance was placed on sedation and abreaction. Many soldiers were saved in numerous useful capacities. Group therapy was possible, and better organisation of social contacts and recreation. Dr. Levy felt that this was distinctly an American contribution, although British psychiatrists have made it an essential part of therapy.

He then discussed personnel selection in Germany and the school where Germans are trained as interpreters, secretaries, investigators, clerks, etc. More than eight hundred have received training there. He pointed out that this gave a unique chance to observe the damage the Nazi regime had done to the national character and personal adjustments. The differences in the family environment between Nazis and non-Nazis were observable.

Dr. Levy believes that the field of political psychiatry is just emerging and will be helpful in the selection of leaders in the new Germany.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 6

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. H. R. Harbottle: "The Provision of Line Communications for the Fighting Services".

Society of Chemical Industry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. G. M. Bennett: "Nitration with Mixed Acids".

Tuesday, January 7

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Prof. H. Hartridge, F.R.S.: "Colours and How we See Them" (Christmas Juvenile Lectures, 5) (succeeding Lecture on Thursday, January 9).*

Institution of Chemical Engineers (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. C. Hall and Mr. A. H. Taylor: "Chemical Engineering Aspects of the Fischer-Tropsch Process".

Wednesday, January 8

Society of Chemical Industry, Microbiological Panel of the Food Group (joint meeting with the Society for Applied Bacteriology, at the Medical Society of London, 11 Chandos Street, London, W.1), at 2.15 p.m.—Dr. J. G. Baumgartner: "Fermentation of Vegetables for Pickle Manufacture"; Dr. T. Richards: "Bacterial Lipolysis and Rancidity in Fats"; Dr. H. H. Evers: "Curing and Fermentation of Tobacco".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. J. H. Partridge: "The Story of Glass" (Dr. Mann Juvenile Lecture).

Royal Society of Medicine, History of Medicine Section (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Dr. A. P. Cawadias: "Clinical Science in the Light of History".

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5 p.m.—Mr. W. B. Reddaway: "The Census of Production".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. L. W. Leyland Cole: "Petroleum Products in Agriculture—The Role of Petroleum in Plant Protection".

Royal Institute of Chemistry, Newcastle-upon-Tyne and North-East Coast Section (joint meeting with the Local Sections of the Society of Chemical Industry and the Institute of Fuel, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Dr. H. E. Crossley: "The Inorganic Constituents of Coal".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. A. Mason: "Radio Transmitting Valves".

Thursday, January 9

Women's Engineering Society, Manchester Branch (at the Engineers' Club, Albert Square, Manchester 2), at 6.30 p.m.—Miss F. B. Fairbrother: "Heating and Ventilation".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Mr. F. A. Robinson: "Recent Developments in Chromatography".

*Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. E. G. H. Carter: "Testing as an Aid to Efficient Finishing".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. B. C. Saunders: "Toxic Fluorophosphonates and related Compounds"; Mr. N. J. Cartwright and Mr. R. D. Haworth: "Some Aspects of the Oxidation and the Dimerisation of Propenylphenols".

Chemical Society, Manchester Section (joint meeting with the Local Section of the Royal Institute of Chemistry, in the Chemistry Department, The University, Manchester), at 7.30 p.m.—Dr. J. H. Schulman: "On Molecular Interaction at Oil/Water Interfaces".

Friday, January 10

Textile Institute, Lancashire Section (at 16 St. Mary's Parsonage, Manchester 3), at 1 p.m.—Mr. W. E. Swale: "Public Electricity Supply and its Application in the Cotton Textile Industry".

Institution of Chemical Engineers, North-Western Branch (in Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Annual General Meeting. Mr. C. E. Rowe: "Aspects of Pilot Plant Development".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the 23rd Duddell Medal to Dr. Karl Weissenberg; Presentation of the 2nd Charles Vernon Boys Prize to Mr. Robert W. Sutton; "Kelvin, Master of Measurement" (sound film).

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. D. M. Smith: "The Development of an Axial Flow Gas Turbine for Jet Propulsion"; Mr. K. Watson Todd: "Practical Aspects of Cascade Wind Tunnel Research".

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. A. Hancock and Mr. T. F. Brown: "Paint Settling—a Suggested Method for Determining the Settling Properties of Paints".

Institute of Physics, Manchester and District Branch (joint meeting with the Institution of Electronics, N.W. England Section, in the New Physics Theatre, The University, Manchester), at 7 p.m.—Prof. D. R. Hartree, F.R.S.: "Recent Developments of Calculating Machines in U.S.A.".

Textile Institute, Bolton Branch (at the Municipal Technical College, Bolton), at 7.30 p.m.—Mr. G. K. Hughes: "Textiles and their Launderability".

Institute of Physics, Midland Branch (at the Imperial Hotel, Birmingham).—Prof. J. M. Meek: "The Nature of the Electric Spark".

Saturday, January 11

Association of British Zoologists (at the Zoological Society of London, Regent's Park, London, N.W.8), at 10 a.m.—Twelfth Annual Meeting; at 10.45 a.m.—Papers on "Careers in Zoology—Possibilities and Training".

Institute of Physics, Electronics Group (joint meeting with the South Wales Branch of the Institute of Physics, in University College, Cardiff), at 3.30 p.m.—Dr. F. A. Vick: "Contact Potentials".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Structural Engineer (temporary) in the Ministry of Finance—The Assistant Secretary (Establishments), Ministry of Finance, Stormont, Belfast, quoting S.B.202/46 (January 10).

Assistant Technical Secretary (male) by the Iron Making Division of the Association—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Iron Making Division' (January 11).

Head of the Department of Horticulture at the Yorkshire Institute of Agriculture, Askham Bryan, York—The Joint Clerk, Yorkshire Council for Agricultural Education, County Hall, Beverley, Yorks. (January 11).

Editorial Officer for the Society's Journal and other publications—The Hon. Secretary, Society of Dyers and Colourists, 32–34 Piccadilly, Bradford, Yorks., endorsed 'Editorial Officer' (January 11).

Graduate Masters for Government Secondary Schools, Seychelles Islands, to teach (*a*) Biology and General Science, (*b*) Mathematics up to School Certificate standard and Junior General Science, (*c*) Geography, History and Civics—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (January 11).

Professional Foresters in the New Zealand State Forest Service—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (January 12).

Lecturer in Humanity in the United College, St. Andrews—The Secretary, The University, St. Andrews (January 15).

Director of Research—The Secretary, British Baking Industries' Research Association, Wellington House, 125–130 Strand, London, W.C.2 (January 15).

Head of the Department of Agricultural Economics, and an Assistant Agricultural Economist—The Principal, Midland Agricultural College, Sutton Bonington, Loughborough (January 15).

Lecturer (male) in Agriculture, and an Assistant Poultry Instructor (male or female)—The Director of Agriculture, School of Agriculture, Houghall, Durham (January 15).

Secretary—The Secretary, School of Agriculture, Cambridge (January 15).

Lecturer (Senior Assistant) in Structural Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (January 17).

Chemist for development work, preferably with experience of chemical engineering, a Research Chemist with experience of plastics, and a Research Chemist with experience of sterols—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6 (January 18).

Lecturers (2) in the Department of Chemistry of the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (January 18).

Head of the Mechanical Engineering Department at the School of Engineering and Navigation, High Street, Poplar, London, E.14—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (January 18).

Lecturer in the Electrical Engineering Department of the South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (January 18).

Senior Assistant in Bacteriology, and a Senior Assistant in Pathology, at the University of Cape Town—The Secretary to the High Commissioner for the Union of South Africa, Trafalgar Square, London, W.C.2 (January 20).

Principal of Grantham Technical College—The Director of Education, County Offices, Sleaford, Lincs. (January 21).

Lecturer in the Department of Engineering of East Ham Technical College—The Chief Education Officer, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6 (January 25).

Senior Chemist (male)—The Clerk of the Board, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (January 31).

Statistician to the Nuffield Department of Industrial Health—The Professor of Industrial Health, King's College, Newcastle-upon-Tyne (January 31).

Assistant Curator at the Essex Museum of Natural History, Romford Road, West Ham—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (January 31).

Research Assistant in the Department of Marine Engineering and Naval Architecture—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

Lecturer in Applied and Industrial Chemistry in the University of Cape Town—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting F.1450A.O. (February 8).

Professor of Engineering—The Registrar, University College, Singleton Park, Swansea (February 8).

Lecturer in Bacteriology—The Registrar, The University, Sheffield (February 15).

Principal—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (February 28).

Chair of Mining and Metallurgy in the Faculty of Engineering, University of Adelaide—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (March 1).

Reader in Marine Engineering at King's College—The Registrar, University Office, 23 St. Thomas Street, Newcastle-upon-Tyne (March 1).

Professor of Agricultural Chemistry—The Registrar, The University, Reading (March 17).

Lecturer in Colonial Agriculture—Prof. Blackman, Department of Agriculture, Parks Road, Oxford (April 20).

Lecturer in Anatomy in the University of Queensland, Brisbane—The Agent-General for Queensland, 409 Strand, London, W.C.2; The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.2.

Junior Research Officer for work on cloth geometry and related fields—The Director, Shirley Institute, Didsbury, Manchester 20.

Lecturer in Physiology, and a Demonstrator of Physiology—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

Laboratory Technician for Physics Laboratory—The Secretary, University College Hospital, Gower Street, London, W.C.1.

Indexer and Abstractor (woman) of technical publications relating to mineral resources—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

Associate Professor of Chemistry and Physics at the Royal College of Medicine, Baghdad, an Expert in Entomology, an Entomologist, and a Soil Technologist—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.13724.

Medical Biologist, Tanganyika (with experience in medical zoology, including parasitology, applied entomology and the epidemiology of parasitic and insect-borne diseases)—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Patent Medicines: an Indictment. By Hugh Linstead. Pp. 32. (London: National News-Letter, 1946.) 1*s*. [148

Department of Scientific and Industrial Research: Building Research. Technical Paper No. 28: Protractors for the Computation of Daylight Factors. By A. F. Dufton. Pp. 16. (London: H.M. Stationery Office, 1946.) 4*d*. net. [148

Monographs of the Quekett Microscopical Club. No. 2: Introduction to the Electron Microscope. By F. E. J. Ockenden. Pp. 24+8 plates. (London: Williams and Norgate, Ltd., 1946.) 2*s*. 6*d*. net. [148

Memorandum on Patent Law Reform. By Joint Chemical Committee. Pp. 118. (London: Association of British Chemical Manufacturers, 1946.) 3*s*. [148

Education (Scotland). Report for the Year 1945 by the Director of the Royal Scottish Museum, Edinburgh. Pp. 12. (Edinburgh: Royal Scottish Museum, 1946.) [148

British Institution of Radio Engineers. Annual Report and Accounts, 1945–6. Pp. ii+14. (London: British Institution of Radio Engineers, 1946.) [158

The Agricultural Development of the Middle East. By Dr. B. A. Keen. A Report to the Director General, Middle East Supply Centre, May 1945. Pp. xii+126+15 plates. (London: H.M. Stationery Office, 1946.) 5*s*. net. [158

Middle East Science: a Survey of Subjects other than Agriculture. By E. B. Worthington. A Report to the Director General, Middle East Supply Centre, August 1945. Pp. xiii+239+16 plates. (London: H.M. Stationery Office, 1946.) 7*s*. 6*d*. net. [158

Soviet Science in the Service of the People, by S. I. Vavilov, and An Outline of the History of the Academy of Sciences of the U.S.S.R., by V. L. Komarov. (Illustrated Soviet Booklets.) Pp. 64. (London: Soviet News, 1946.) 1*s*. 6*d*. [208

Ministry of Agriculture and Fisheries. Bulletin No. 120: Root Vegetables. Pp. 24+4 plates. (London: H.M. Stationery Office, 1946.) 9*d*. net. [208

Other Countries

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 1007: Surface Water Supply of the United States, 1944. Part 7: Lower Mississippi River Basin. Pp. vii+378. 60 cents. Water-Supply Paper 1009: Surface Water Supply of the United States, 1944. Part 9: Colorado River Basin. Pp. vii+360. 55 cents. Water-Supply Paper 1010: Surface Water Supply of the United States, 1944. Part 10: The Great Basin. Pp. v+181. 35 cents. Water-Supply Paper 1011: Surface Water Supply of the United States, 1944. Part 11: Pacific Slopes in California. Pp. viii+405. 60 cents. Water-Supply Paper 1014: Surface Water Supply of the United States, 1944. Part 14: Pacific Slope Basins in Oregon and Lower Columbia River Basin. Pp. v+222. 40 cents. (Washington, D.C.: Government Printing Office, 1945–1946.) [158

Uganda Protectorate. Annual Report of the Forest Department for the Year ended 31st December 1945. Pp. ii+17. (Entebbe: Government Printer, 1946.) 2*s*. [208

U.S. Department of the Interior: Geological Survey. Professional Paper 205-B: Minerals of the Montmorillonite Group; their Origin and relation to Soils and Clays. By Clarence S. Ross and Sterling B. Hendricks. (Shorter Contributions to General Geology, 1943–44.) Pp. iv+23–80+8 plates. (Washington, D.C.: Government Printing Office, 1945.) 35 cents. [218

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 971: Surface Water Supply of the United States, 1943. Part 1: North Atlantic Slope Basins. Pp. x+613. 1 dollar. Water-Supply Paper 972: Surface Water Supply of the United States, 1943. Part 2: South Atlantic Slope and Eastern Gulf of Mexico Basins. Pp. viii+503. 1 dollar. (Washington, D.C.: Government Printing Office, 1945.) [218

Durban Museum and Art Gallery. Annual Report for the Year ended 31st July 1945. Pp. 8 + 4 plates. (Durban: Durban Museum and Art Gallery, 1946.) [278

Universidad de Buenos Aires: Facultad de Agronomia y Veterinaria. Publicacion No. 2: Reseña de la sanidad vegetal en la Republica Argentina. Por Prof. Juan B. Marchionatto. Pp. 117. Tomo 1, Fasicolo 1: Oftalmia periodica. Por Prof. Alvaro S. Campori. Pp. 69. (Buenos Aires: Universidad de Buenos Aires, 1945–1946.) [278

South African Journal of Science. Vol. 42: Being the Report of the Forty-third Annual Meeting of the South African Association for the Advancement of Science, Johannesburg, 1945, 2nd, 3rd and 4th July. Pp. xxiv + 273. (Johannesburg: South African Association for the Advancement of Science, 1946.) 30*s*. net. [278

Annual Report of the Research Council of Alberta, 1945. (Report No. 47.) Pp. 21. (Edmonton: King's Printer, 1946.) [278

Research Council of Alberta. Contribution 10: Recent Work of the Research Council of Alberta. By Edgar Stansfield. Pp. 12. (Edmonton: King's Printer, 1945.) [278

Smithsonian Miscellaneous Collections. Vol. 104, No. 23: The Cedartown, Georgia, Meteorite. By Stuart H. Perry. (Publication 3844.) Pp. ii + 4 + 4 plates. Vol. 106, No. 1: The Birds of San José and Pedro Gongález Islands, Republic of Panamá. By Alexander Wetmore. (Publication 3845.) Pp. ii + 60 + 4 plates. Vol. 106, No. 8: Turtles collected by the Smithsonian Biological Survey of the Panamá Canal Zone. By Karl Patterson Schmidt. (Publication 3852.) Pp. ii + 9 + 1 plate. (Washington, D.C.: Smithsonian Institution, 1946.) [278

Smithsonian Institution: Bureau of American Ethnology. Bulletin 137: The Indians of Southeastern United States. By John R. Swanton. Pp. xiii + 943 + 107 plates. (Washington, D.C.: Government Printing Office, 1946.) 2.75 dollars. [278

Smithsonian Institution: United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1944. Pp. iii + 100. 35 cents. Report on the Progress and Condition of the United States National Museum for the Year ended June 30, 1945. Pp. iii + 112. 25 cents. (Washington, D.C.: Government Printing Office, 1945–1946.) [278

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Classics of Science and Medicine. (Catalogue 125.) Pp. 138. (London: Davis and Orioli, 1946.)

A List of the Publications of the Ray Society. Pp. 4. (London: Bernard Quaritch, Ltd., 1946.)

A Catalogue of Books on Zoology, Geology and Palaeontology, Botany, and a Selection of Herbals. (No. 640.) Pp. 96. (London: Bernard Quaritch, Ltd., 1946.) 6*d*.

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ECONOMIC STATUS OF MEN AND WOMEN IN THE PROFESSIONS

SCIENTIFIC workers who are bold enough to glance through the two hundred pages of the report of the Asquith Commission on Equal Pay will not find it easy at first to discern its exact bearings on their own activities. A brief chapter on the professions, and the sections on the non-industrial Civil Service and the Post Office in that on the Central Government Service, the chapters on the teaching service and on the local government services other than teaching, are the portions of the factual survey forming Part 1 of the report which obviously closely concern particular categories of men of science. Another chapter in the same part reviews equal pay in the United States of America, in Australia, in France and the Union of Socialist Soviet Republics. In Part 2, where the implications of the claim of equal pay for equal work are considered at length, the physiologist and psychologist may find something of interest in the discussion of the natural factors responsible for the prevailing differences in the remuneration of the labour of men and women and of the psychological effects of equal pay, as well as of the effects on the health and efficiency of women as workers. It is, however, on these explanations of the prevailing differences that there is a memorandum of dissent by Dame Anne Loughlin, Dr. Janet Vaughan and Miss L. F. Nettlefold, and there is a further reservation by Lord Justice Asquith, Sir Jasper Ridley and Prof. D. H. Robertson on the question of over-strain.

It is accordingly no surprise to find that the only approach to a summary is a paragraph directing attention to passages in which the conclusions of the Commission are briefly crystallized, and that these conclusions are limited to the social and economic effects of applying equal pay to the Civil Service, to teachers and to local government officers other than teachers. The general implications for industry are left open to debate, and although the consequences of its application, which in the Commission's view are common to all spheres, are considered at large in a further chapter, on one point raised the Commission was not unanimous. The purely financial consequences of equal pay are discussed in a final chapter, in which it is estimated that introduction of equal pay in the non-industrial Civil Service on the basis of 1939 figures would involve a gross annual cost of £4 millions, or £13 millions on the basis of the October 1944 numbers and sex-distribution. The probable increase when the Civil Service has settled down to its peace-time strength and sex-composition might lie between £5 millions and £10 millions. For England and Wales, the Ministry of Education estimates that the annual cost of raising the salaries of women teachers to the men's level would be about £14·5 millions, while for other employees of local authorities the Commission estimates the annual cost at about £750,000.

Turning now to the factual part of the report, which since the report is rather the opening chapter of a new volume of discussion than the basis for action—in any event until ample time has been allowed for digestion—is probably the more important, no evidence was submitted of women with professional status charging lower minimum fees than men with the same status. Evidence from some professional bodies showed that their recognized scales provide for the charging of identical fees by men and women. As regards salaried posts, a broad distinction is drawn between employment in the public service and employment outside. In the Civil Service, women medical and dental practitioners receive the same salaries as men; but the principle of equal pay has not been accepted as yet for other professions, although the Royal Institute of British Architects is pressing the case for equal pay for men and women architects in the Government service.

Some witnesses suggested that outside the public services there was no differentiation between men and women as regards remuneration, and evidence submitted to the Commission indicates that professional men and women actually receive equal salaries for the same work, outside employment in central and local government, when practising as medical practitioners, dentists, physiotherapists, radiographers, university teachers and journalists and librarians in technical or specialized libraries in industry. Women pharmacists working for hospitals or for wholesale and manufacturing chemists are also stated to receive, in general, the same rates as men. A small section of the evidence submitted, however, indicated discrimination in salaries between men and women; for example, in retail pharmacy, welfare work and personnel and labour management. A table giving the numbers of men and women in certain professions shows the extreme variations of the sex distribution, from about 3,000 women out of 6,000 librarians, according to an estimate made by the Library Association, 7,198 women out of 44,341 medical practitioners, 2,667 women out of 25,224 pharmacists, 549 out of 15,404 dentists, 325 out of 9,700 architects and 261 women out of more than 9,000 chemists.

Passing now to the few conclusions drawn in the report, the Commission states that there is no reason to suppose that the grant of equal pay in the Civil Service would have as corollary a change in the policy of recruitment designed to restrict the employment of women, and while the present system of recruitment remains in force it is unlikely that equal pay would have the effect of increasing to any important degree the proportion of women in the Civil Service, although some increase may naturally be expected. Such increase is likely to be most marked at the administrative level, and is likely to be accompanied by an improvement in the quality of the persons recruited. The consequences are only likely to be important—and adverse—if the common rate is not held at a level at which it competes effectively with the rates payable outside the Service to men of the type and quality which are required. The effects in the local government service, other than teaching, are considered as likely to be broadly similar but slightly less impressive.

As regards teaching, the Commission considers that any risk that the quantity or quality of male recruits would be adversely affected by a system of equal pay would be more than offset by the natural effect of such a system in attracting more or better women to enter the teaching profession. It also emphasizes that the grant of equal pay would redress a sense of injustice which the majority of teachers, men as well as women, rightly or wrongly entertain.

It is not easy in reading this report 'to see the wood for the trees', and there are many points which cannot well be viewed in their proper perspective against the scanty conclusions already noted. Discussing, for example, the marriage bar in relation to equal pay, the Commission observes that in the professional, administrative and technical classes of the Civil Service, the bar is harmful so far as it increases the natural wastage, and results in a further shrinkage of the pool from which women in whom much training and experience has been sunk can be made available for filling the highest posts. Against this, of course, has to be set the risks of inconvenience and embarrassment to the public service from endeavouring to retain in employment women who may require considerable spells of maternity leave, and whose domestic duties may restrict their mobility and their availability for the long hours of work which may be required at times of crisis and pressure.

The report makes it abundantly clear that, for most professional and administrative workers, the change-over to a regime of equal pay for the two sexes involves a serious clash of equities and social purposes. Some of those may be resolved by Government social policy as regards children allowances, income taxation and the like outside the terms of reference of the Royal Commission; but their existence tends to reinforce the argument which the Commission displays for Government initiative. It is argued with force that, if equal pay is to be introduced immediately and as an act of deliberate policy in any sphere, the 'area' of its introduction should be confined to those same spheres of non-industrial Government employment to which the Commission's own conclusions have been restricted. That step might well be justified at the moment as helping to meet the need for trained man-power and woman-power at the administrative level; and although as indicated in the report there are considerable difficulties in the way of adoption of an equal pay policy in private industry and commerce, it is almost certain that Government initiative in the spheres indicated would be followed at least tentatively by many sections of industry in corresponding fields.

Whatever is done in any part of this field may be expected to have strong reactions elsewhere, and in directing attention to the probability that private industry would probably follow a Government lead, the Commission comments mildly on the argument put forward by the Treasury against the Government taking action independently of employers in Britain generally. The Treasury, it seems, fears that changes in the large field of employment which it controls in the non-industrial field would have too large an effect on outside practice. At the same time, however, the Treasury resisted the introduction of equality in the Government's industrial establishments because, before the War, they covered such an extremely small part of the industrial field that the Government could not attempt to exercise a dominant influence in the sphere of industrial wages. This unconvincing attempt to make the best of both worlds and do nothing might well have received more pointed rebuke. It may be wrong, for reasons given in the report, to argue from the consequences of establishing equal pay in the public service to the consequences of establishing it in private industry; but there is a strong case for throwing the example and influence of the Government on the side of reducing the gap between the pay of men and women at the present time. If the adjustment is to be faced, it is well for it to be done while the relationships of costs, selling prices and the value of money are still in flux; and as a recognized instalment of social justice and an increment to the labour force, there are immediate benefits to be set against the cost.

There are, therefore, chapters of this report which scientific and other professional workers will do well to ponder, and the absence of definite conclusions should not prevent them from forming their own as to the effect and implications of the adoption of equal pay in the Civil Service, and probably also in commerce, following a Government lead. The factors to be weighed are duly set forth, and the minority report, which seeks to distinguish more clearly between opinions and evidence, reflects a more advanced and buoyant attitude than that of the majority, although it might have been more fully and cogently displayed. Both majority and minority reports, however, are a distinct contribution to clearer thinking on the many issues involved, and they deserve in particular careful study by all professional associations concerned with the economic status of their members. On what is said as to career value and the relative turnover of women as compare withd men staff; the trend towards the substitution of mechanical for muscular power; and the truism that no material object or human quality derives value merely from the fact that it is uncommon, but only from the fact that it is scarce relative to the demand for the services which it is capable of rendering, there is room for further objective thinking by such bodies, as well as by individuals, before action is taken even on the limited findings of the Commission.

THE FUNCTIONAL *A PRIORI*

The *a Priori* in Physical Theory

By Arthur Pap. Pp. xi+102. (New York: King's Crown Press; London: Oxford University Press, 1946.) 13*s*. 6*d*. net.

THE King's Crown Press is undertaking the admirable task of making the contributions of scholars more readily available than they might otherwise be if they always had to carry the full 'editorial attention' of Columbia University. There is no diminution in quality; rather it is a case of 'high thinking and low living', but with a somewhat tempered austerity, altogether appropriate to a monograph on a philosophical theme.

Dr. Pap will be known in Great Britain by his lucid paper on "Indubitable Existential Statements" (*Mind*, p. 234, July 1946); in the present context he appears as the expositor of a certain doctrine, namely, the functional, of the *a priori*, both in its historical aspect and in its application to classical physics. In both these domains he is strongly under the influence of C. I. Lewis and of Poincaré, though he does not hesitate to launch out on his own into deep water as opportunity offers.

Before making any detailed comments, it may be permitted to invite those seriously interested to have a copy of Prof. E. A. Milne's "Fundamental Conceptions of Natural Philosophy" (Scott Lecture, Royal Society of Edinburgh, 1943) before them when they tackle the thesis now under review. The point is this. Milne devotes considerable attention to classical physics, comparing them closely with his new theoretical edifice in process of construction. The core of the whole adventure, however—for it is nothing less—is an insistence upon the supreme significance of epistemology, and upon the need to use it properly. Now this is just what Dr. Pap has done, and done very well. In fact, whether he had this in mind or not when writing his manual (for he is silent on the question), the conjunction could scarcely be better. In parallel or in series, these contributions form a natural pair, which is not because they are alike; it is because for both it is the epistemology that matters.

From here, as from a springboard, we may well take off to follow up this new work. In Part 1, as already indicated, the treatment is largely historical, and in Part 2, in application to Newtonian mechanics. The discussion seems to be airborne from the start: the groundwork is good, but the reader is soon given wings. This applies both to the text itself and to the footnotes. The latter contain much valuable material, not clogging the machinery, but acting, as it were, as a lubricant.

Some early paragraphs show Lewis as a pragmatist, so far as the *a priori* is concerned. It is difficult to see what difference there is between his view and the essentially 'John Blunt' statement that *a priori* means 'true, no matter what'. This may well be, but he rejects, as Kant did, the *tabula rasa*; the mind does not start for Lewis with a clean sheet; but he will have none of the "*a priori* forms of induction", nor of the "synthetic *a priori*" either. Altogether, this seems a trifle 'queer'—to use an adjective which the Harvard philosopher employed in another connexion. Dr. Pap's *a priori* is rather gentler and, as he says, "may well be viewed as susceptible of *degrees*". The impact of Poincaré's "La Science et l'Hypothèse" on the writer is more profound, and brings about a certain axiological orientation almost amounting to a species of requiredness. At the same time, there is a strong leaning towards physics, as indeed there must be if Poincaré's thought is to bear fruit.

Alongside, another notion is ably handled, namely, that of 'real definition'. A quotation from John Stuart Mill follows, which, if taken in its original context, makes the position most intriguing. Mill had, in fact ("System of Logic", 1, Chapter 8, Section 5), just been discussing Archbishop Whately's "Logic", in which real definition is taken to contain more than is implied in nominal definition, whereas De Morgan held just the reverse (always assuming, of course, that the content is enough for distinction), his real definition having a smaller content than the nominal. Real definition seems fundamentally afflicted with a certain fuzziness: it is interesting to compare the two for the case of formal implication, remembering that 'nominal' refers to notation. Thus, in the usual symbols:

$$(\mathrm{F})(\mathrm{G})[[\mathrm{F}(x) \supset_{x} \mathrm{G}(x)] \equiv (x)[\sim \mathrm{F}(x) \vee \mathrm{G}(x)]] \ldots \text{(real)},$$

and

$$\mathrm{F}(X) \supset_{X} \mathrm{G}(X) \ldots \text{(nominal)}.$$

One might almost see in this a perpetual distinction between the methodologies of the mathematical and classificatory sciences, the former, as Dr. Pap points out, favouring definition by postulate (unknown to Mill), and the latter explicit definition, that is, the traditional *definiendum* → *definiens*. As a long footnote explains, unambiguous discriminants between the two can be obtained. More generally, Whately's charming Aristotelianism may again find favour in our day, though doubtless in a rather different dress.

Meanwhile, a few pages ahead, a somewhat crucial state of affairs is reached for *definiendum* and *definiens*, in virtue of the synthetic-analytic shift of meaning and the consequential generalization by selective abstraction. Naturally enough, the old anthropomorphism of force appears here, and a reference is given to the Kasimir Ajdukiewicz concept known as the *Begriffsapparatur*. This is a kind of language pattern, tightly connected and bounded with respect to meaning. But for once, what Dr. Pap has in mind about this is not entirely clear. Now Ajdukiewicz has three kinds of rules—axiomatic, deductive and empirical; what exactly they, and they alone, have to do with the difference between force (synthetic) and force (analytic) is hard to see. It may be that the text suffers from excessive condensation; but the truth behind this distinction is of the greatest significance in view of the close correspondence between Poincaré's 'principles' and 'conventions' with the first and third rules of the *Begriffsapparatur*. In point of fact, Ajdukiewicz considers that our whole outlook is a function of language as well as of experience.

Thus far for the functional *a priori* itself: we now approach its application to Newtonian mechanics. Dr. Pap begins by reminding us of the relations and *Grundsätze* of Kant, and their assumed position with regard to Newton's laws of motion; namely, the principle of the permanence of substance, the principle of causality, and the principle of reciprocity on one hand, and the law of inertia, the law of the proportionality of force to acceleration, and the law of action and reaction on the other. One illustration, from the law of inertia, must suffice to illustrate the structure of the author's thought. Here it is argued that, in general, the fundamental laws of Nature contain an experimental element and a conventional element; or, otherwise expressed, there is a dichotomy into an *a priori* component and an *a postiori* component. As an example of this dual character, the first law of thermodynamics, $dU = dQ - dW$ is mentioned. Mathematically, this merely amounts to defining internal energy in terms of measurable quantities; the physical significance appears when dU is established as a perfect differential, for this means the usual conditions and result for, say, a Carnot cycle. It looks as if much of the difficulty commonly encountered in mastering classical thermodynamics is traceable to the undue haste with which the subject is usually presented, lacking a clear epistemological basis, while the perfect differential emerges as a species of *deus ex machina*.

Whether or not it would be strictly germane to the author's purpose, the impression remains that this section would have been enriched by a discussion of Carathéodory's axiomatic thermodynamics, either in the original form or in the more readily grasped version given later by Prof. Max Born. The objection, supposedly, would be that an analytic, quasi-geometrical conception is not in the spirit of Newtonian physics, at least in the traditional setting. But perhaps nothing would mirror with less distortion the main tenets of Dr. Pap's philosophy. This is not a criticism, only a plea.

While on these subjects, a word or two upon what the writer calls "the graphical idealization of distributions of experimental values", or the principle of uniformity. This, of course, is a well-known assumption revived, namely, that a functional relation connecting verified data will hold for values not actually measured, and which, moreover, may never in fact be measured. In practice, it has not infrequently been necessary to rescue the principle of uniformity from disruption, and one way is to increase the number of parameters of a simple analytic function, say, the general gas law, $pV = RT$. In brief, we start with $f(p,V)$, then suspecting that temperature is the culprit, we write $f(p,V,T)$; lastly, we save the situation by increasing the dimensionality, thus putting $(p+a/V^2)(V-b) = RT$, so retaining our continuous function.

Some such process is involved when efforts are made—as they occasionally are—to set up a natural philosophy of 'real' substances in contradistinction to the simplified bodies necessarily envisaged in academic science. Alternatively, it may be desirable to approximate to a widespread imperfection (or defect), such as that manifested by 'real' crystals. But the fundamental importance of a grasp of the principle of uniformity remains; otherwise there is a grave risk of becoming profligate, and inviting due retribution from Occam's razor.

These topics, and many more, form the raw material out of which Dr. Pap has fashioned his last chapter, that on idealization in physics. They all tell the same story—the need for a sound epistemology and for the will to use it.

An adequate set of notes and a bibliography provide a final reminder of the wide field covered by this monograph, and of how much yet remains to be brought under the plough. F. IAN G. RAWLINS

SCIENTIFIC BASIS FOR SYLVICULTURE

Forest Soils and Forest Growth

(Plant Science Books, Vol. 18.) By Assoc. Prof. S. A. Wilde. Pp. xxii+242+7 plates. (Waltham, Mass: The Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1946.) 5 dollars.

DR. WILDE'S book is written for practical foresters and forestry students, whose success or failure in their work will be judged by volume and quality of crop production combined with maintained soil fertility. His main theme is summed up in his preface: "an understanding of the forest lies just as much below as above the ground"; but in the text more space is given to a consideration of soils than vegetation. From the point of departure he passes, after an introductory chapter, to a discussion of the genesis and classification of forest soils, followed by a series of short chapters on forest cover, soil properties, soil survey, sylviculture and forest nurseries. The great virtue in the author's treatment of these subjects lies in his conception of soils as dynamic systems. Each type has its own morphological structure and pedological activity which is integrated completely with the structure and activity of the living community dependent upon it. He does not use Prof. Tansley's term 'ecosystem'; but the concept is clear. The virgin forest, the exploited forest, the plantation and even the forest nursery are viewed as possible systems of this kind maintained either by natural or anthropogenic forces. The aim of the forester is to extract from such systems the maximum volume and quality of his product while maintaining by suitable treatment stability or rhythmic change within it. By a combined study of pedology, ecology and physiology, Dr. Wilde has attempted to find a scientific rationale for sylvicultural and nursery operations.

Such is the impression given by a complete reading of the book as a whole; but equal justice is not done to all parts of the subject, and one is left with a profound feeling of disappointment. The material presented was based originally upon a series of lectures given to a heterogeneous group of students, and this origin seems to have determined the mode of presentation. It is doubtless also responsible for the inclusion of most of the less-important material. The size of the subject, as defined in the title of the book, is huge; and alone would have been sufficient to fill the two hundred pages available. Nevertheless, chapters or sections are included on the purely technical or elementary aspects of soil survey, tree-felling, mensuration, extraction and parasite control which are sufficient only to whet the appetite of the reader or to distract his attention. The omission of some of this material would greatly have improved the balance and order of the all-important remainder. The most regrettable feature is the restriction of the discussion on the biological structure of forest cover to one short, inadequate chapter of eight pages in which the interdependence of sylviculture, ecology and soil science is included. This defect is partly rectified by a valuable later chapter on soil-forest types in which a comparison is made between communities of the United States and those of other parts of the world. Surely these two chapters might have been more closely related to one another and to that upon soil organisms, which again is somewhat simplified and placed among chapters on soil properties. In short, the book is so composed and constituted as to make it very difficult for the reader to obtain a clear panorama of the whole subject.

The treatment of soil genesis and classification contrasts sharply with the remainder, both in its detail and in its arrangement. It will be to this part of the book that one will return for reference. The classification of forest soil types is summarized by a table in which each 'macro-climatic-soil-forest zone' is subdivided into its principal genetic types on the basis of degree of leaching. In the following text each type is described with examples of structure, analysis and associated tree species in most cases. The author stresses that there is a dearth of accounts correlating pedological and ecological observations upon soils of the lateritic group. He has, however, produced an outline of the forest soils of tropical regions which is worthy of further consideration.

As has been suggested, much of the detail of the last eighty pages might better have been omitted so that the sylvicultural and nursery principles and practice could have been more closely related to the fundamentals laid down in the first part of the book. Each of the short chapters in these pages is in itself a clear account of some practical operation, even though it is not closely related to the general text.

The book is printed and bound to conform with the sister volumes of a new series of *Chronica Botanica* publications, and it is illustrated with clear black-and-white figures in the text. The plates, which are interleaved with the index, are often too small and too crowded, but the tail-pieces to the chapters are delightful. To sum up, it must be realized that Dr. Wilde has undoubtedly approached his subject from a new angle, and that the book is a step towards the consolidation of the many branches of academic study which unite in the practical subject of scientific forestry. J. L. HARLEY

X-RAY AND ELECTRON DIFFRACTION IN FLUIDS

The Diffraction of X-Rays and Electrons by Free Molecules

By Dr. M. H. Pirenne. (Cambridge Series of Physical Chemistry.) Pp. xii+160. (Cambridge: At the University Press, 1946.) 12*s*. 6*d*. net.

THE present monograph is intended to give an account of the phenomenon of diffraction of X-rays and electrons by gases and the methods for determining the structure of atoms and molecules based on the observation of this phenomenon. But it also deals to some extent with the scattering of X-rays by crystals and by liquids in so far as these phenomena can be used for the same purpose.

The first part of the book deals with the classical and quantum theory of the coherent and incoherent scattering of X-rays and the mechanism of the fluorescent radiation of atoms, the experimental measurement of the scattering by monatomic gases and crystals, and the comparison of the results of these measurements with theory. The scattering of fast electrons is then treated in a similar way. Next the diffraction of X-rays by free rigid molecules is considered theoretically and the theory verified by experiments on gases consisting of simple molecules. This is followed by considerations on the effect of the mutual interference of molecules in dense gases and especially in liquids, owing to the existence of a radial distribution function. The next part of the book deals with the refinement of the theory by taking into account the internal thermal movement of the atoms within the molecule and the distortion of the electronic clouds of the atoms connected with the chemical bonds. This is followed by a discussion on the use of X-ray and electron diffraction measurements on free molecules for the determination of their geometrical structure and, in particular, the use of Fourier analysis of diffraction patterns for this purpose. Finally the experimental methods for the measurement of X-ray scattering functions of gases are described in detail, especially the methods developed by the author himself. A list of molecules studied by these methods, a table of atomic scattering functions and a bibliography are added.

The book is in the first place written for scientific workers who wish to engage in research on the structure of molecules. There is therefore no attempt to derive the theoretical formulæ from first principles, and at every step the theory is put to the test by comparison with experiment. The virtues of the different methods, the errors to be avoided and the corrections to be applied are very thoroughly discussed; but perhaps a little too much space is taken up by the detailed description of the author's own work as compared with the work of others. Those readers who wish to use the book as a source of general information on the subject would have preferred to find a short systematic theoretical treatment of the scattering of X-rays and electrons on the basis of quantum mechanics, which would greatly help towards a better understanding of the connexions between the different forms of the scattering phenomenon.

There are a few minor errors; for example, the statement on p. 21 that the frequencies in the spectrum of the incoherently scattered radiation are all smaller than the primary, or the statement on p. 26 that in coherent scattering the primary photon is first captured by the atom and then re-emitted again in its entirety. The discussions on pp. 12 and 28 on the quantum mechanical wave function are incorrect as they omit to take into account that these functions are complex and not real. The explanation of the resonance effect produced by the K-frequencies on the dispersion of the atomic scattering factor on p. 38 is also misleading.

Apart from these minor defects the book is very lucidly written and accompanied by a great number of clear diagrams and illustrations. It can be warmly recommended. R. FÜRTH

CHEMISTRY AND LIGHT

The Chemical Aspects of Light

By E. J. Bowen. Second edition revised. Pp. iv+300. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 15*s*. net.

MR. BOWEN writes in his preface that "the second edition of this book has the same aim as the first: to present modern ideas of matter and light as far as possible in non-mathematical form. . . . Wave mechanics is a difficult subject which cannot by its intrinsic nature be conveyed in a pictorial form, yet such a theoretically unsound task is what is attempted here". There can be no doubt that Mr. Bowen has succeeded in his task; moreover, the task itself has increased in magnitude since the first edition was published; and, in general, wave mechanical topics have been treated more deeply in the second edition.

The arrangement of the book remains approximately the same; but the text has been largely rewritten and extended. The early chapters on light and waves, and light and light sources remain sensibly unchanged. Chapter 3 on the absorption and emission of light has been considerably enlarged. The main addition is a discussion of molecular orbitals, and their construction from and relation to the corresponding atomic orbitals. In the course of this, carbon–carbon single and multiple bonds, and conjugated systems, including benzene, are dealt with. There follows a very interesting account of 'colour', in which the position, shape and intensity of absorption bands are related to molecular structure, molecular orbital and resonance methods being used. Chapter 4, on the transformation of absorbed radiation, now includes a discussion of the kinetics of the quenching of fluorescence in solution, and the information which may be obtained by a study of quenching about reactions in solution with high velocity constants.

Typical additions in the remaining chapters are the discussion of a number of photochlorinations, and geometrical isomerizations (Chapter 6) and the recent Russian work on photosynthesis (Chapter 7). There are also two additional appendixes: one on filter solutions, and a comprehensive list of "Experiments with Light of Chemical Interest".

For readers who are not familiar with the first edition, it may be stated that the book is written in an extremely lucid and attractive style, and will be useful not only to students as an introduction to several aspects of chemical physics, but also to practical photochemists. The author is to be congratulated on adding substantially to the value of an already excellent book. It is a pity that references to original papers have been omitted from the second edition.

The price is very reasonable.

C. H. BAMFORD

LEGENDRE POLYNOMIALS

British Association for the Advancement of Science

Mathematical Tables. Part-Volume A: Legendre Polynomials. Prepared by the Committee for the Calculation of Mathematical Tables. Pp. A42. (Cambridge: At the University Press, 1946.) 8*s*. 6*d*. net.

THIS is the first of a post-war series of mathematical tables published for the British Association, in response to the ever-growing demand arising from research work in mathematics and physics.

It is designated Part-Volume A, and appears in conjunction with a companion volume on the Airy integral. Unlike the other recent publications dealing with the tabulation of Legendre functions, this book makes no reference to the associated functions and is concerned only with the polynomial solution of Legendre's differential equation:

$$(1-x^2)\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + n(n+1)y = 0,$$

for integers n ranging from 2 to 12 inclusive.

In the first section, tables of $P_n(x)$ for $n = 2$ to 6 are provided for the range $x = 0$ to 6 at intervals of 0·01. The entries are, in general, accurate to seven significant figures, and second differences are supplied.

The second section deals with the next three functions with similar accuracy, fourth differences being included where necessary. The remaining three functions are tabulated in the final section.

The whole production has been supervised by Dr. L. J. Comrie and is prefaced by his introduction, which describes the material on which the tables are based, together with the methods used in their construction. With his characteristic thoroughness, Dr. Comrie has provided means for ensuring the complete accuracy and legibility of every figure, and one can look forward with confidence and pleasure to future publications of a similar nature. J. H. PEARCE

INTERNATIONAL CONTROL OF ATOMIC ENERGY*

STATEMENT FROM THE COUNCIL OF THE ATOMIC SCIENTISTS' ASSOCIATION

THE United Nations Atomic Energy Commission has before it the two alternative proposals by the American delegate (Baruch plan) and by the Russian delegate (Gromyko plan). Mr. Philip Noel-Baker stated in the House of Commons on August 2 that there is no fundamental clash of principle between these two plans, and that they need to be fused; we share his belief that efforts must be continued to find a workable scheme acceptable to all countries.

We have come to the conclusion that the points on which the nature of the disagreements has been brought out most clearly are concerned with the stages by which an ultimate solution is to be approached.

A. Immediate Action

The most important objection to the Baruch plan from the point of view of other nations is probably that it envisages in its first stages measures which may be construed as maintaining the dominance of the United States in the field of atomic energy, whereas the concessions which are to be made by that country appear mostly in the later stages. If these later stages are not to be ratified until the previous ones have been achieved, technically Congress could withhold ratification at any stage.

(1) It appears to us essential that the Baruch proposals be amplified by making it clear that a definite succession of steps should be laid down from the outset and be accepted by each nation participating in the scheme. Each step is to come into effect upon a decision by the Atomic Energy Commission, or other agency of the United Nations, that the conditions laid down for the stage have been realized. In this respect, once the charter for the authority has been adopted, there should be no need for further ratification of each step by each country. The refusal by any member nation to implement these decisions would then be equivalent to a violation of the agreement setting up the Atomic Development Authority (A.D.A.).

(2) Notwithstanding the solemn undertaking already made by signatories to the United Nations Charter to refrain from all acts of aggression, it is not unreasonable to ask these nations in addition to reaffirm the undertaking with special reference to atomic weapons and all other weapons of mass destruction.

(3) Another point of difference is that the Russian proposals require the destruction, within a limited period, of existing stocks of weapons, whereas the American proposals would postpone this stage until an effective system of safeguards has been established. On this question it is easy to understand the reasons for either point of view, but we think it would be reasonable to ask at least for a declaration by all countries of the amounts of fissile materials in their possession and of the production-rates in existing or projected plants. Such a declaration might materially contribute to a spirit of confidence, while not appreciably impairing the security of the United States. We hope, in particular, that it may be possible to make these valuable materials available for productive uses rather than to destroy them. It is unlikely in any event that nations would agree to the destruction of the precious fissile materials, and without this the mere dismantling of existing bombs would be of no value, since the fabrication of bombs from the fissile materials is not likely to be the bottleneck in the production of weapons.

(4) If it is decided that the first step should consist of a complete survey and control of raw materials, it should be understood that during this first phase all nations should still be free to proceed with the construction of plants and the use, in such plants, of the raw materials accessible to them. The aim would be to submit these plants and any materials produced by them to the control of the A.D.A., at the same time as such control takes effect for the plants and stocks now existing in the United States.

(5) We believe that the chance of agreement and the rate of development of the beneficial uses would, in fact, be greatly improved if a generous view were taken of the definition of 'basic scientific knowledge' which can immediately be exempted from secrecy rules. We also suggest that it would be a generous and helpful gesture if the nations now possessing the most advanced knowledge of atomic energy were to offer to other nations collaboration in setting up small atomic reactors, which are of little use for military purposes but are valuable for the purposes of scientific research and for the production of tracer elements for research in medicine and other fields. Collaboration in the construction of such small reactors should not only consist in a transmission of the necessary data but also in exchange of scientific and technical personnel, and might involve the sale or loan of certain special materials of construction as far as the supply of such materials is available. This step, we believe, would offer immediate advantages to all the nations concerned which would far outweigh any contribution they make to the dissemination of technical experience of some value also for military applications.

B. Nature of Ultimate Control Scheme

(6) Turning now from the immediate action to the features of the ultimate control scheme, the point that has given rise to most controversy is the question of the veto. We think it unfortunate that this point should have reached such prominence in the early phase of discussion, before other features of the plans had been adequately considered. We believe that the relations of the A.D.A. to the rest of U.N.O., and in particular to the Security Council, have to be specified more clearly than was done in the Baruch proposals. It is clear that there cannot be two independent bodies responsible for the enforcement of international agreements, and that since the

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* The final version of this memorandum was determined on November 28; it was supported by most members of Council of the Association, but two members felt unable to support the whole of it.

A.D.A. cannot supersede the Security Council, the A.D.A. has to be subject to the direction of the Security Council in matters of policy, and that A.D.A. cannot take upon itself the function of defining and punishing a violation of the agreement. As long as the U.N.O. charter provides for the right of veto in certain decisions of the Security Council, we do not see how the application of sanctions in matters which concern the A.D.A. can be made independent of this right. While definite provision for the veto exists and is likely to remain an essential part of the charter, it is, of course, essential that procedure be developed which limits the use of the veto to matters of fundamental importance without unduly hampering progress in the work of the Security Council. This point, the relevance of which is by no means limited to problems connected with atomic energy, is now being discussed by the permanent members of the Security Council.

(7) On the other hand, if A.D.A. is to carry out effectively the control of raw materials and is to own facilities for development and production, it will have problems of day-to-day management in which progress is impossible unless it possesses a certain degree of autonomy over such matters, which leaves it free to take decisions without referring each question back to the Security Council, and without the possibility of being blocked by a veto over technical matters. The line between administrative problems which are the province of the A.D.A. and policy problems to be settled by the Security Council is, of course, difficult to draw and, while rules can be framed after careful study of the situations likely to arise, there remain borderline cases in which the question of procedure will have to be settled by the Security Council, or possibly by the General Assembly of U.N.O.

(8) It is an important feature of the Baruch plan that all 'dangerous' production facilities, that is, all those that are easily adapted to the production of military weapons, should be owned by A.D.A. On this point the Gromyko plan makes no specific proposals, although points (2) and (3) of the terms of reference of the second committee proposed in that plan provide for discussions which might possibly lead to a scheme of the same general type.

What precisely is meant by 'ownership' is not very clearly specified, either in the Baruch plan or in the Lilienthal Report. Full ownership, in the usual sense of the word, would meet with difficulty, since it would give A.D.A. the right to decide whether power plants could be built in any country and the right to withhold the use of the power produced in such a plant or to place conditions on the supply of such power. Such restrictions would give the possibility of interference in the economic life of each country to a degree not essential to the purpose of preventing the abuse of atomic energy for destructive purposes. On the other hand, it would appear essential, in order to conform with the spirit of the Lilienthal proposals, that A.D.A. should take over the operation of such plants with the right of ensuring that any dangerous products were consumed in power plants and that no excessive stockpile be produced. We have no perfect solution to offer to this problem, but we feel that a careful study of the precise meaning of A.D.A. ownership should lead to a scheme that would be free from objections and that would provide both a safeguard against the accumulation of dangerous materials without the approval of A.D.A. and the opportunity for nations to take the initiative in building up within their territory efficient atomic power plants to supplement their other resources of power.

A scheme which, in this way, would circumscribe the powers of A.D.A. over national plants could minimize the difficulties arising from suspicion of interference with the economic structure of a country.

An alternative and less ambitious suggestion is to limit the function of A.D.A. to the inspection of plants and control over the distribution of products. In this connexion, however, we are impressed with the strength of the case made in the Lilienthal Report for giving to A.D.A. positive responsibility for production and ownership and with the difficulties outlined there of maintaining an effective inspection under any conditions. There is considerable doubt as to whether a control scheme not containing this feature would offer sufficient security.

(9) The positive functions of A.D.A. will be further strengthened if it is accepted that the Authority should itself undertake research on all problems of atomic energy. Its research organisations should be strong enough to ensure for A.D.A. a lead in knowledge of all scientific and engineering aspects of the problem and to make it desirable for most countries to call in its help in setting up and designing new plants. The existence of A.D.A. research organisations need not exclude national research, provided the latter is carried out openly and its results made available to A.D.A. In fact, the closest co-operation could be expected between the Authority and national research. At the very least, an A.D.A. research organisation should carry out the function of an essential clearing house of all information on the technical problems and should help to disseminate and co-ordinate the results of national research institutions.

(10) One of the key factors of control is that of raw materials, and here it is not sufficient to leave national initiative unimpaired, since in the absence of a free market the access to raw materials must be covered by international agreement. This problem is related to the general problems of access to raw materials other than atomic fuels; but it is outstanding among them because of the supreme military and future economic importance of atomic fuels. A solution to this problem should be sought in relation to the more general problem as well as in relation to the general agreement for the control of atomic energy.

(11) We do not believe that it is necessary to class research on atomic explosives as a dangerous activity; the danger does not come from research as such, but from the application of the results. The object of a control scheme is to ensure that the results of such research would never be used for destructive purposes; but, in addition to any engineering uses of atomic explosives, the knowledge of the possibilities of atomic weapons is essential to make effective plans for preventing their illicit manufacture or use. We believe that it would be a sufficient safeguard to ensure that research agencies not directly owned by U.N.O. should have no access to dangerous amounts of material, except under the supervision of A.D.A., and to require that all such research be carried out openly and that any relevant results be immediately reported to the A.D.A.

(12) A further important question is that of inspection. We have stated previously that the problem would be made easier if all dangerous plants were owned by A.D.A.; but there remains the problem of ensuring that they are indeed the only existing dangerous installations. If nations were prepared to rely on each other's good faith, the whole problem of control of atomic energy would not arise. As things are, they can feel secure only if there exists some form of inspection. It is desirable that the right of inspection should be circumscribed so far as possible and should not be a means of excessive prying into legitimate industrial or other activities. This is a question which can only be settled by extensive discussion. One might contemplate a procedure similar to a search warrant which would give the right of entry upon certification by A.D.A. that there exist reasonable grounds for suspicion. But one has to bear in mind that the discussion of the question whether in any given case there are reasonable grounds for suspicion may well lead to so much friction as to hamper seriously the work of A.D.A. We feel that the kind of inspection that merely aims at satisfying itself that any given mine or chemical plant is not handling large quantities of uranium or thorium ore, or that any given factory is not a separation plant or pile, is so different in type and order of magnitude from the kind of inspection that would disclose manufacturing secrets that it ought to be possible to work out a scheme which allows the one and prevents the other.

One key feature in preventing illicit production plants is the control of all natural uranium and thorium, and it seems to us essential that A.D.A. should have access to and control of all such material at the source. One cannot, however, rely on this measure exclusively on account of the possibility of some future discovery, such as an economic method of extracting uranium from low-grade ores, since in this way it might become possible to produce uranium as a by-product of other mining operations.

As a result of these discussions, it seems to us that the suggestions we have made ought to be considered as a basis of a workable scheme which in some measure surmounts the objections raised against the earlier proposals, and that, while they will no doubt have to be modified so as to adapt them to the views of the countries concerned, a discussion based on similar lines would give hope of finding a scheme that, of all possible control systems, has the greatest chance of being acceptable to everybody.

Conclusion

It must be admitted that an effective system of control acceptable to all concerned is a very doubtful proposition in the present state of distrust between nations, since it must contain, at least in embryonic form, a measure of world government. It is felt by some of our members that we can scarcely expect any effective agreement on the control of atomic energy at the present time. The above suggestions have been put forward in the hope that they will clear ideas with regard to a plan which we can only hope will be a feasible proposition before long. Some of the suggestions might, however, be put into effect immediately, mainly some of those we have listed under "A. Immediate Action". These might help in creating a favourable atmosphere for a workable system of control.

SILVER JUBILEE OF THE BRITISH CAST IRON RESEARCH ASSOCIATION

By J. G. PEARCE

Director of the Association

THE British Cast Iron Research Association was among the last of that early group of research associations to be established after the First World War, and, without departing from the basis of voluntary adhesion by interested and eligible firms, has raised its annual income from some £3,000 to last year's record of £40,000. The Association is concerned with the iron-founding industry, its raw materials, equipment, processes and products, together with their applications, and it endeavours to improve quality, facilitate manufacture and extend the uses of cast iron.

The material commonly termed 'cast iron' is, in fact, a range of iron–carbon alloys technically highly complex and readily differentiated from the steels, for they contain more carbon. Cast irons have an extraordinarily wide use in industry, including building and architecture, the engineering, chemical and metallurgical industries and domestic life. Before the Second World War, the industry had an output of some 2·5 million tons a year and employed about 100,000 people. It is anticipated that the demand will rise to 3·5 million tons by 1950. While cast iron is the cheapest of the ferrous alloys, its widespread use is due not only to low first cost and, under normal conditions, to comparatively rapid delivery, but also to the fact that for certain purposes it is unsurpassed. Engine crankshafts and camshafts constitute its most recent applications, for which it has proved highly successful. Foundry pig iron, the blast furnace product which forms the major raw material of the industry, is, metallurgically, a cast iron.

The properties of cast iron are determined in part by composition and in part by structure, which is not wholly determined by that composition. When the carbon in the metal remains combined as the hard, brittle carbide of iron, the resulting white iron casting has these properties. White irons can be annealed to give the product malleable cast iron, which is ductile. The bulk of the output, however, is of machinable grey cast iron, in which the task of the ironfounder and of the metallurgist is to adjust composition and section so that a small proportion only of the carbon remains combined, the balance being deposited as free carbon or graphite, usually in the form of microscopically visible flakes. In malleable cast iron the graphite is deposited in a nodular or spheroidal form known as temper carbon, and annealing in the solid state is the only way hitherto known of producing this structure.

Between the World Wars, iron-founding passed from the stage of craftsmanship to the possibility of scientifically controlled production, and as a result of investigations in various countries, notably Britain, the United States and Germany, the strength of cast iron was doubled. This was mainly accomplished by improving the metal matrix through reduced silicon and carbon contents, alloy additions, thermal treatment, and by better melting techniques and improved understanding of moulding sands. While the use of graphitizing ladle additions became popular, giving more uniform graphite, its flake form remained unaltered. Remarkable advances were also made in the production of special-duty, as distinct from high-duty, or mechanically strong, cast irons for service conditions involving heat-, corrosion- and wear-resistance. The British Cast Iron Research Association, in exploring the causes of growth and scaling, evolved[1] the heat-resisting iron known as 'Silal', containing about 5 per cent silicon, and, later[2], the austenitic cast iron 'Nicrosilal'. Austenitic irons have found a number of industrial uses[3]. They are characterized by their relative ductility, non-magnetism, and corrosion- and wear- as well as heat-resistance. The mode of failure of ingot moulds for steel ingot, an exceptionally severe service, was also explored[4].

Ordinary cast iron has a mixed ferritic–pearlitic matrix, and the engineering irons are usually fully pearlitic. They may be annealed to the ferritic state for rapid machining. They may be stress relieved without structural change, or they may be submitted to quench and temper heat-treatments in the same way as the steels. To-day, practically any other desired structure, austenitic, martensitic or cementitic, of the metallurgical matrix can be made to predominate in cast iron. Furthermore, by alloying, a ferritic matrix can be made highly resistant to mineral acids, in the high silicon irons, and to heat and corrosion in the high chromium irons.

Development. Early in its life the British Cast Iron Research Association recognized the importance of accompanying the creation of new knowledge through research with means for its application in industry through what is conveniently termed 'development', and with means for its dissemination through information and intelligence. Development, in addition, covers treatment of a wide range of problems arising from technical and practical foundry difficulties, which keep the staff in close touch with the industry. Considerable improvements have been made in the cupola furnace, the industry's universally used melting unit. Of one type evolved by the Association, the balanced blast cupola, more than three hundred have been installed, with an aggregate melting capacity of 2,400 tons an hour, half in Great Britain and the remainder in some twelve countries overseas. The development side is actively concerned with casting design, that is, the economical disposition of material. During the War it dealt with the anti-glare problem for the industry's furnaces, together with the technical aspects of the fuel situation. A number of research contracts were also carried out for official departments.

The research and development staffs are aided by a group of specialized laboratories, chemical, spectrographic, physical, metallographic, mechanical testing, sands and refractories, as well as by an experimental foundry.

Research. The research programme can be divided roughly into two parts. The first comprises what Sir Edward Appleton has aptly termed "objective fundamental research", that is, exploratory work designed to increase background knowledge for the industry served by the Association. The second part comprises investigations aiming at specific and clearly defined ends, either necessary to the fundamental programme or needed by the industry. To illustrate this section, reference may be made to the evolution and evaluation of new and improved methods of testing and control, and the application of new instruments and apparatus to the materials and processes of the industry. The metallurgical complexity of cast iron—the number of elements involved is never less than six and may reach twice that number—makes this a difficult task. Methods of testing and control of moulding sands and other foundry materials, methods of testing and specification of the product, wet analytical methods, application of the spectrograph and the photo-electric absorptiometer, have all been covered. For the future, X-ray diffraction, the electron microscope, radiographic and gamma-ray examination for defects, supersonic testing, polarographic and micro-chemical methods must be considered. Much *ad hoc* work comprises the determination of mechanical and physical properties needed by the engineering designer at ordinary, sub-normal and elevated temperatures[5]. Early work in this connexion has included the rationalization of the widely used transverse test for cast iron and the relationship between toughness of the material and the plastic component of transverse deflexion[6]. Various grades of grey cast iron can be obtained to national specifications in British Standards Specifications 321 and 786.

It is necessary to confine a brief review to metallurgical work, and as an illustration of work on the fundamental side the mechanism of graphite formation may be chosen. This has been pursued over a period of years, interrupted by the War, in the conviction that the fullest potentialities of cast iron can only be realized if the size, form and distribution of graphite can be controlled, and that such control can only derive from an understanding of the mechanism of formation.

Graphite formation. The characteristic flake form in grey iron and the temper carbon or nodular form in malleable cast iron have been mentioned. Another form of very finely divided graphite was known, although the circumstances of its formation were obscure. It was established, however[7], that this form was encouraged by allowing the melt to undercool, and it is therefore called 'undercooled graphite'. Later it was found that flake and undercooled graphite formed in melts of otherwise similar composition were produced by varying the conditions of melting[8], which were more important, in fact, than composition variations. A major step forward took place when the undercooled form was produced at will from a melt that would otherwise solidify in flake form, by ensuring the presence of a small amount of titanium in the melt, and treating it while molten with carbon dioxide[9]. Structures exclusively composed of undercooled graphite were produced in cast iron which without treatment conformed to the ordinary flake pattern, and which could be made to revert by treatment of the melt with hydrogen. This work gave considerable impetus to the theory that flake graphite formed on pre-existing non-metallic oxide or silicate inclusions, but direct microscopic examination revealed that pig and cast iron showed no traces of such oxides or silicates[10], while chemical examination gave values too small to support any superstructure of theory[11]. It was, in fact, shown that pig and plain cast irons are more free from oxides and silicates than the steels, while the only non-metallic inclusions of consequence comprised the sulphides. A recently published study has confirmed this[12] in respect of the alloyed cast irons containing nickel, copper, chromium, molybdenum and other elements. These results directed attention to the influence of gases and to a more fundamental examination of the position.

In recent years the theoretical metallurgist and the physicist have done much work in studying elements related in the Periodic Table and in electronic structure. The value of the predictions of the physicist has been realized and studies were made of the nickel–carbon and cobalt–carbon alloys to see whether their behaviour would throw any light on the iron–carbon alloys as exemplified in the cast irons. The results of the work of Morrogh and Williams are being published by the Iron and Steel Institute, and embody a complete statement of the phenomena which require to be explained by a comprehensive theory of graphitization. In addition, the work provided the necessary lead towards the production of nodular graphite in as-cast material; and since the completion of this report it has proved possible to obtain nodular graphite in cast iron as also in the nickel–carbon alloys.

Although the nodular graphite produced directly in the mould resembles that obtained in malleable cast iron, the new structure does not have the properties of malleable cast iron (for example, as in British Standards Specifications 309 and 310), which has a comparatively low carbon content and the advantages of a lengthy homogenizing anneal. Nevertheless the new structure does have a small but measurable elongation and area reduction, together with static tensile and transverse properties and impact strength double or treble those of the same material in the untreated state. In fact, ordinary hæmatite pig iron can be melted and treated to give the mechanical properties of what are now regarded as high-duty cast irons. Thus, a hæmatite iron gave, in the untreated and treated states, tensile strengths of 15·5 and 26·5 tons per square inch, transverse strengths of 29·4 and 47·9 tons per square inch, and impact strengths of 13 and 47 ft.lb. (a British Standards Specification for the cast iron impact test is pending) respectively. In a 4·0 per cent carbon hæmatite, of one hundred bars cast, ten chosen at random had their tensile strengths between 23·8 and 24·3 tons per square inch, and Brinell hardness numbers between 198 and 203, indicating a very high degree of uniformity.

The presence of phosphorus in foundry pig irons makes the influence of this element of particular importance in practice. Phosphorus up to the amounts studied does not interfere with the new structure, although in high-phosphorus irons, the phosphorus must be expected to exercise its dominating effect on strength.

The austenitic irons lend themselves well to the new treatment. A 'Niresist' of 10 tons tensile and 30 ft.lb. impact strength gave, on treatment, a tensile strength of 20–25 tons per square inch and 120 ft.lb. (unbroken) impact. A 'Nicrosilal' iron in the untreated and treated states gave a transverse deflexion of 0·75 in. and 3·5 in. (unbroken) respectively.

These preliminary results require amplification before a more complete statement is possible; but there is little doubt that this is the most significant advance in the metallurgy of cast iron in the present century, and that the new material will lift ordinary cast iron to a new plane, as well as forming a base for the production of still stronger high-duty irons. The pursuit of this work, both in respect of its theoretical basis and its industrial application, must form a major item in the Association's future programme.

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TIMIRIAZEV, FOUNDER OF SOVIET GENETICS

By Dr. G. H. BEALE
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KLIMENT ARKADIEVICH TIMIRIAZEV is to-day regarded by Soviet botanists as one of their chief authorities, mainly on account of his life-long support for Darwinism. In Great Britain, however, his work is but little known, apart from a few references in text-books of plant physiology. We are therefore interested to see L. S. Tsetlin's short account of Timiriazev's life and work[1], which has recently appeared in the Soviet Academy of Science's popular scientific series of biographies. Having read this book, one can well appreciate why the name of Timiriazev is now so highly esteemed in the Soviet Union.

Kliment Arkadievich was born in 1843 in St. Petersburg. His father, a government official, came of an ancient Russian noble family; but, we are told, "held republican views, and had a revolutionary temperament"; his mother was English, and no doubt it was from her that he acquired his great interest in England. Already at the age of fifteen, in order to earn money, he was daily reading *The Times* for a Russian paper, and translating Dickens and other English novelists into Russian. He remained an Anglophile all his life. He is quoted as having said: "Of all civilised nations, the English are the most remote from scientific conceit and pedantry", and "it was no accident that it was amongst the great English people that there appeared a thinker who has made evolution the corner stone of modern thought".

Timiriazev was elected a foreign member of the Royal Society in 1911, eight years after delivering the Croonian Lecture; and it was not only British science which he admired, for he is reported to have expressed a fondness for the English landscape, and the paintings of Constable, Gainsborough and Turner.

In 1861, Kliment Arkadievich entered the University of St. Petersburg but was soon obliged to leave, on account of student unrest, and he finished his course in 1866 as a private student in natural sciences. This was the time of the liberation of the serfs in Russia, and Timiriazev states that the enthusiasm for progressive movements which he gained during the 'sixties remained with him for his whole life.

After spending two years abroad, in Heidelberg and Paris, he was appointed in 1870 a teacher (later professor) at the newly founded Petrovsky Academy of Agriculture and Forestry in Moscow (now the Timiriazev Academy), and engaged in teaching and research in plant physiology until 1892, when he was expelled. From 1877 he was also a professor of plant physiology in the University of Moscow, until 1901, when he was likewise excluded from its professorial body. Evidently his views on "free scientific thought, freedom of instruction, and autonomy of places of higher education", did not accord with those of the educational or ecclesiastical authorities, and consequently he was never made a full member of the Imperial Academy of Sciences.

In 1909, Kliment Arkadievich had an apoplectic fit, and became paralysed. However, he retained possession of his mental faculties for another ten years. He died in 1920.

Apart from some early work in 1867 on the effect of mineral fertilizers on rye and oats, practically all Timiriazev's research was concerned with photosynthesis. Thus he made some experiments on the relative effects of different parts of the spectrum on photosynthesis, and attempted to prove, in accordance with his materialist views, a proportionality between photosynthesis and the amount of energy absorbed by the plant in the form of light.

Timiriazev's views on plant physiology are summarized in a book called "The Life of the Plant", an English translation of which appeared in 1912. The material for this book was originally taken from a course of lectures delivered in 1876 in Moscow, and embraces a wider range of topics than is now included in plant physiology. The first chapter is called "Science and Society", in which Timiriazev expresses the view that "the physiology of plants will develop in the schools of agriculture in the same way as the physiology of animals developed in the schools of medicine", and "obviously the physiology of plants must be made the foundation of agriculture". In these views Timiriazev was many years ahead of his times. In the last chapter, devoted to the "Origin of Organic Forms", he states: "naturalists hail Darwin's theory as the crowning of the stately structure of modern physiology".

In 1864, five years after the appearance of Darwin's "Origin of Species", Timiriazev published an article entitled "Darwin's Book, its Critics and Commentators", and from that time until the end of his life never ceased to be an enthusiastic propagandist for Darwin. Timiriazev's "Struggle for Darwinism" (as L. S. Tsetlin calls it) took the form, in the main, not of original observations and experiments, but of polemics with various of his compatriots. The two principal Russian anti-Darwinians were (1) N. Ya Danielevsky (1822–85), "one of the reactionary epigones of slavophilism", who published in 1885 and 1889 two massive volumes purporting to reduce Darwinism to an "amorphous heap of rubbish", and (2) N. N. Strakhov (1828–96), a "naturalist philosopher and publicist". Timiriazev also ventured to differ, with respect, from the great Tolstoi, who in his novel "Anna Karenina" and elsewhere had attacked the principles of natural selection. Such criticism of Darwin in nineteenth-century Russia, based on nationalism, ethics, or a non-materialist philosophy, is now, however, of little scientific interest in comparison with the violent controversies which raged after the re-discovery of Mendel's famous paper in 1900.

On the subject of Mendelism, Timiriazev expressed himself with characteristic vigour. Thus, in the prefaces to the fifth, sixth and seventh edition of his book, "Charles Darwin and his Work" (1905, 1908, 1919 respectively, and reprinted in 1941), Timiriazev writes [reviewer's translation]:

"I demonstrated the failure of the attempts to refute Darwinism by the clerics and metaphysicians, and, in Germany, by the nationalist Chauvinists. The ungifted, obstinate Bateson has continued to act as leader of the clerical anti-Darwinian movement in England. . . . As is known, he has greatly exaggerated the significance of Mendel's work, endeavouring to obscure the importance of Darwinism with the over-inflated glory of a catholic monk", and so on.

Notwithstanding this onslaught, it is of great interest to note that Timiriazev at the same time saw no inconsistency in pointing out certain virtues in Mendelism. Before the discovery of Mendel's laws, the theory of natural selection had been exposed to criticism on account of the then widely held assumption of blending inheritance. Thus Fleeming Jenkin, professor of engineering in the University of Edinburgh, had, in 1867 [2], pointed out that if a plant or animal should arise, deviating by an amount n from the normal, then, with cross-fertilization, members of the next generation would show a deviation of only $n/2$, and the next after that only $n/4$. Consequently, there would be a 'swamping effect' on every newly arising variation, and the chance of natural selection acting on such variations would be extremely slight. (This has been pointed out in more recent times by Fisher in "The Genetical Theory of Natural Selection".) Apropos of this, Timiriazev, in a speech delivered in 1909 [3], fifty years after the publication of the "Origin of Species", said:

"The answer to Jenkin's objection was given already two years before the appearance of his article. In 1865, a completely unknown Augustinian monk named Mendel published a paper . . . showing that characters do not blend, but are preserved unchanged, and are distributed between various descendants. . . . *Thus, Mendelism removes the most dangerous objection which, in the words of Darwin himself, was made against his theory*".[3] [My italics.]

It is greatly to his credit that Timiriazev should here put aside his anti-Mendelian prejudices, which were doubtless due partly to his dislike of religion in general and consequently of Mendel for his clerical association, partly to the fact that Mendelism was taken up in a distorted form by the German so-called race theorists, and partly again to the hostility towards natural selection felt by Bateson and other Mendelian enthusiasts.

Timiriazev's incorporation of Mendelian segregation into the theory of natural selection is correct according to the views of modern genetics. It is, however, contrary to the teachings of the Lysenko[4] school, at present dominant in the U.S.S.R., and Lysenko is described by Tsetlin as Timiriazev's "ideal pupil". It is therefore the more regrettable that Tsetlin in his book fails to direct attention to this inconsistency, and merely points out that "Timiriazev acknowledged Mendel's undoubted merit".

As is well known, Darwinism has been accepted as part of the official *Weltanschauung* of the U.S.S.R. Karl Marx, writing to Engels in 1860 about the

"Origin of Species", said: "This book gives a natural-historical basis to our views", and since then the parallelism between "Das Kapital" and "The Origin of Species", which appeared within eight years of each other, has often been drawn. Tsetlin adds: "in widely spreading propaganda for Darwinism, Timiriazev was preparing among his numerous pupils and readers a favourable soil for the planting of dialectical materialism".

Shortly before Timiriazev's death in 1920, there appeared a volume of his more political writings, collected under the title "Science and Democracy", in which he welcomed the Bolshevik regime. For this he received a letter of hearty thanks from Lenin himself.

Tsetlin, in the preface to his book, states that his purpose is to follow the progress of Timiriazev's views "from bourgeois democracy to communism, through the medium of his own particular science". A good case is certainly made out for this; but it is a pity that Timiriazev is misrepresented in at least one important respect (that is, concerning Mendelism). Indeed, Kliment Arkadievich Timiriazev was, in the view of the present writer, a greater man than perhaps appears from Tsetlin's book.

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[1] Timiriazev, by L. S. Tsetlin, U.S.S.R. Acad. Sci., 1945. Pp. 153 (in Russian).

[2] *North Brit. Rev.*, June, 1867.

[3] I have translated this passage from p. 207 of the 1941 edition of Timiriazev's book, "Charles Darwin and his Work".

[4] See Ashby, E., *Nature*, 158, 285 (1946).

OBITUARY

Prof. F. M. Rowe, F.R.S.

Frederick Maurice Rowe, born at Stroud, Gloucestershire, in 1891, died at his home in Leeds on December 8. One of a long line of Clothworkers' Scholars from Marling School, Stroud, he entered the Department of Tinctorial Chemistry and Dyeing of the University of Leeds in 1908, graduated with first-class honours in tinctorial chemistry in 1911, and was president of the University Union during 1911–12.

After a period of research with Prof. A. G. Green on nitrohydrazo compounds and *o*-nitroamines, Rowe joined the research staff of Messrs. J. Crosfield and Sons, Ltd., of Warrington, in 1913, and was sent to study colloid chemistry with Freundlich at the Technische Hochschule, Braunschweig, Germany. In 1916, however, he resumed his association with Green, who had been appointed director of the newly established Dyestuffs Research Laboratory at the College of Technology, Manchester. Two years later, he became head of the Laboratory, where he remained until 1926. During this period, the work on *o*-nitroamines was continued, and the properties of certain azo dyes derived from hydrogenated naphthalene derivatives were investigated. He also examined tars obtained from the low-temperature carbonization of coal, and elucidated the constitution of certain yellow pigment colours, for example, the Hansa Yellows, and the composition of some rapid fast printing colours and products used in the production of insoluble azo colours. For these and other investigations he was awarded the degree of D.Sc. by the University of Leeds in 1921, and the fellowship of the Institute of Chemistry in the same year.

This was a period of re-birth for the dyestuffs industry of Great Britain and, conscious of his special responsibilities to the industry, Rowe accepted the invitation of the Society of Dyers and Colourists to undertake the heavy task of compiling and editing an authoritative work of reference on colours, their composition, method of manufacture, properties and uses. The "Colour Index" was the result, and of all Rowe's achievements it is the one most closely associated with his name. He was awarded the Gold Medal of the Society of Dyers and Colourists in 1934 in recognition of his "exceptional services to the Society and to the tinctorial industries as Editor of the *Colour Index*, 1924, and the *Supplement*, 1928".

After being appointed reader in tinctorial chemistry at the College of Technology, Manchester, in 1925, Rowe was elected to the chair of colour chemistry and dyeing at the University of Leeds in 1926, on the retirement of the late Prof. A. G. Perkin. His subsequent research was in two main fields. The first arose out of the observation that phthalazine derivatives are formed by the action of excess sodium hydroxide on the diazosulphonate derived from diazotized *p*-nitro-aniline and β-naphthol-1-sulphonic acid. On extending the work to diazosulphonates derived from other nitroamines and their derivatives, results of such interest and importance were obtained that the series of papers increased to twenty-five, some of which, though written, await publication. In addition, he undertook research on the preparation and properties of intermediates for dyes and related products.

The second main line of investigation was concerned with the application of dyes, and ranged over a wide field. Among the subjects studied were the effects of after-treatment on the aggregation, location, shade and fastness properties of insoluble azo dyes on the fibre; the reduction and dispersion of azoic dyes in presence of Lissolamine A; and the fading of dyeings on cellulose acetate rayon, due to the action of oxides of nitrogen in the atmosphere. In later years, particular attention was paid to the dyeing of wool with chrome mordant dyes. Starting with a study of the peculiar dyeing properties of wool which had been exposed to the action of light and air, the work was extended to include fundamental work on the chroming of wool and an exhaustive study of the metachrome process.

Rowe's distinction as a research worker was recognized by the award of the Worshipful Company of Dyers' Research Medal on five occasions, and by his election to the fellowship of the Royal Society in 1945. He was admitted to the livery of the Worshipful Company of Dyers in 1932, and to the honorary freedom and livery of the Worshipful Company of Clothworkers in 1944. Such distinctions were the reward of a life characterized by a high sense of duty: duty to his students, whose subsequent careers he followed with close personal interest; duty to the University, where his wise counsel will be sorely missed in a period of reconstruction and development; and duty to the industry, of which he was the academic focus. It was typical of the man that, despite these many responsibilities, he should accept a commission in the Home Guard at the time of its formation. The accumulated burden was then too great, and his health gave way in 1943. Yet indomitable courage enabled him to continue academic work to the very end of his days.

E. J. Cross
J. B. Speakman

NEWS and VIEWS

Physics at Middlesex Hospital Medical School: Prof. Sidney Russ, C.B.E.

PROF. SIDNEY RUSS, as announced in *Nature* of January 4, has recently retired from the Joel chair of physics, attached to the Middlesex Hospital Medical School, and been appointed emeritus professor of physics in the University of London. Prof. Russ was the doyen and one of the most distinguished members of the group of hospital physicists who have played an important part in developing the science of medical radiology. After a brilliant career as an undergraduate at University College, London, he was appointed demonstrator in physics at the University of Manchester. Here he became one of Rutherford's earliest research associates, and with the late Prof. W. Makower investigated the phenomenon of the recoil of atoms undergoing radioactive disintegration. His interest in radiology led to his appointment in 1910 to a Beit Memorial Fellowship tenable at the Middlesex Hospital, a connexion with this institution which remained unbroken until his retirement in September last. On the expiry of his fellowship he was appointed physicist to the Hospital, and later, in 1920, was appointed to the first chair in physics at a London medical school.

As an investigator and administrator, and also as a lecturer possessing great charm and lucidity, Prof. Russ has exerted a considerable influence on medical radiology. Probably his most notable contribution to the subject is the book which he published in collaboration with the late Dr. H. A. Colwell entitled "Radium, X-Rays and the Living Cell". This pioneer work attracted many to this field of investigation and stimulated the interest of a much wider circle. Later, again in association with Colwell, he published another work, "X-Rays and Radium Injuries", and was joint author with his colleagues, L. H. Clark and B. D. H. Watters, of the well-known "Physics in Medical Radiology". He also contributed a succession of original papers on the influence of radiation on living cells, organs and tumours. In addition to being honorary secretary of the Radiology Committee of the Medical Research Council, the first scientific secretary to the National Radium Commission, and radium adviser to the King Edward Hospital Fund, Prof. Russ was for many years a member of the British X-Ray Units Committee and of the British Committee for X-Ray and Radium Protection. The present international recommendations relating to X-ray units and to radiation protection are largely based on the work of the British Committees and owe much to Prof. Russ's knowledge, zeal and wisdom.

Prof. J. E. Roberts

DR. J. E. ROBERTS, who has been elected to fill the Joel chair of physics at the Medical School of the Middlesex Hospital, University of London, is a graduate of Leeds. He has for some years been associated with hospital physics mainly in connexion with radiotherapy. His work with Prof. W. V. Mayneord at the Royal Cancer Hospital resulted in his appointment about ten years ago to the Middlesex Hospital. His main research in the field of pure physics has been an attempt to formalize the energy distribution in the gamma-ray spectrum of radium B and C.

American Association of Physics Teachers: Award of Oersted Medal

THE Oersted Medal of the American Association of Physics Teachers has been awarded to Prof. Duane Roller, professor and head of the Department of Physics of Wabash College, Crawfordsville, Indiana. The award is made annually "for notable contributions to the teaching of physics". Through the *American Journal of Physics*, which he has edited since it was founded in 1933, Prof. Roller had made a notable contribution to the teaching of physics at the college and university levels. Prof. Roller was educated at Culver Military Academy and at the University of Oklahoma. He was later, for thirteen years, on the staff of the University of Oklahoma, during which period he received a doctorate at the California Institute of Technology. Afterwards he became a research associate at Columbia and an associate professor at Hunter College. During the First World War he was a pilot, and during the Second World War he was chief technical aide of the National Defense Research Committee. The formal award will be made at the annual meeting on January 31 of the American Association of Physics Teachers, to be held at Columbia University. In his address of acceptance Prof. Roller will discuss one of his chief professional interests, physical terminology, another field in which he has made notable contributions, both to the teaching of physics and to the science itself.

British Medical Journal: Retirement of Dr. Gerald Horner

THE news that Dr. Gerald Horner retired under the age limit from the editorship of the *British Medical Journal* at the end of 1946 will be heard with regret by all those who have benefited, during the last nineteen years, from his able editorship. The editing of a leading medical journal, which is also the official organ of the British Medical Association, has always been a high responsibility. During recent years it has carried with it an increasing preoccupation with the health and well-being, not only of the people of Great Britain, but also with that of great and harassed populations elsewhere. If, indeed, we seek a measure of the achievement of Dr. Horner, we shall find it in the fact that the whole world looked to the *British Medical Journal* for guidance and leadership.

Formerly an assistant editor of the *Lancet*, the staff of which he joined in 1911, Dr. Horner became editor of the *British Medical Journal* in January 1928. Under his editorship the circulation of the journal has increased so considerably that he cannot but have felt, when he left the editorial chair, that his labours have been well rewarded. It has fallen to his lot to edit the journal throughout the very difficult period of the recent War, when the paper shortage, air raids and a multitude of other difficulties coincided with the necessity of providing, every week, a journal well filled with news and informative and research articles. Among the latter were the records of noteworthy results of British war-time research; and their publication and the issue of a great deal of other information was an essential part of our war-time effort. How efficiently Dr. Horner discharged this task is well known; as are also his kindly and helpful influence and personality. During the later months of his editorship, the British Medical Association planned and launched no less than eight new specialist medical journals, each with its own editor. His experience must have been an invaluable aid in the planning of these additions to medical literature. His advice must have been essential also to the successful planning of the two new abstracting journals which began publication by the British Medical Association this month under the general direction of the editor of the *British Medical Journal*. These new journals, namely, *Abstracts of World Medicine* and *Abstracts of World Surgery, Obstetrics and Gynœcology*, are modelled on the *Bulletin of War Medicine*, which under the able editorship of the director of the Bureau of Hygiene and Tropical Diseases, Dr. Charles Wilcocks, and the publications officer of the Medical Research Council, Dr. F. H. K. Green, gave, until its publication was discontinued in 1946, so remarkable an epitome of medical work during the War.

Dr. Hugh Clegg

DR. HORNER has done a great work. It will be a satisfaction to him—and to everyone else—to know that the journal which he has so ably edited will now be in the hands of Dr. Hugh Clegg, who has been, since 1934, assistant editor. Dr. Clegg brings to his task a vigour of character, a broad outlook and an experience of medical journalism which make it certain that the great traditions of the *British Medical Journal* will be maintained. Everyone will wish him success in a work which may well have, during the period upon which we are now entering, a greater influence upon the health of the public and of the individual than medical journalism has ever had before.

Biology and Human Affairs

THE autumn issue of this useful journal maintains the high standard that teachers of biology and others interested in the broader aspects of biology (including social biology and human affairs) have now come to expect. Edited and produced by officers of the British Social Hygiene Council, the journal has also the advantage of a strong board of editorial consultants—Profs. F. A. E. Crew, J. Ryle, T. H. Pear, S. Zuckerman, and Dr. A. I. Richards, Mrs. E. M. Hubback and Mr. L. G. Troup.

The current number deals with science and ethics as a follow-up of the Conference on Science and Ethics organised by the British Social Hygiene Council last July. E. J. H. Corner, of the Botanic Gardens, Singapore, contributes a stimulating article dealing with tropical biology as an international problem. Sir John Megaw discusses over-population as a world problem. Sir John gives much food for thought, especially when discussing the possible effect on population problems of the World Food Plan envisaged by the Food and Agricultural Organisation. The report of the Council's Summer School held at Wadham College, Oxford, reveals the value that teachers and local authorities are attaching, to an increasing extent, to these gatherings. An informative article on the biology of twins is contributed by F. Whitwam Jones; and one on democracy and museum zoology by the keeper of zoology, National Museum of Wales (Colin Matheson), is provocative and suggestive. Book reviews play an important part in this journal—an excellent publication which should be read by all biologists interested in the teaching and social implications of their subject, and especially by school teachers. It is published by the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

New Scientific Journals

THE newly founded Society for General Microbiology is to issue the first number of its journal—the *Journal of General Microbiology*—during January (Cambridge University Press). The journal will be edited by B. C. J. G. Knight and A. A. Miles; the associate editors are G. C. Ainsworth, W. B. Brierley, T. Gibson, A. T. R. Mattick, Kenneth Smith, A. W. Stableforth and D. D. Woods. For the time being there will be three numbers a year, the annual subscription being 50*s*. Further information can be obtained from the Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1.

The Nutrition Society is also to produce a new journal—the *British Journal of Nutrition*—which will be issued quarterly. It is hoped to publish the first number during the first half of 1947. The editorial board is as follows: D. P. Cuthbertson, J. N. Davidson, R. C. Garry, G. Graham, J. Hammond, E. M. M. Hume, S. K. Kon (chairman), I. Leitch, W. C. Miller, B. S. Platt, J. A. B. Smith and F. Yates. This journal is also to be published by the Cambridge University Press, from which further particulars can be obtained.

British Association

SIR HENRY DALE, who succeeded Sir Richard Gregory as president of the British Association on January 1, was formally installed at a meeting held at Burlington House on January 3, and addressed a joint meeting of sectional committees assembled to consider the programme for the meeting of the Association in Dundee next autumn. For the first full post-war meeting of the Association, the Council has adopted a general theme 'Swords into Ploughshares', and prominence will be given in the programmes to papers and discussions on the positive contributions which science has made, and can make, towards the well-being of mankind.

Carnegie United Kingdom Trust

THE thirty-second annual report of the Carnegie United Kingdom Trust, for the year ended December 31, 1945 (from the Trust, Dunfermline), states that the Trustees have decided to revert to the pre-war system of arranging the business of the Trust in certain main groups, and for this purpose have reconstituted standing sub-committees of the Executive Committee dealing, respectively, with arts, community services, education, youth services and finance and general purposes. The accounts of the Trust, which are now again printed as an integral part of the report, show a total expenditure on grants of nearly £75,000 or about £3,500 more than in 1944. Of this, £30,343 is for youth services, £23,733 for community services, £10,634 for the arts and £8,731 for education. The expenditure for youth services was represented chiefly by capital grants in aid of equipment of youth clubs and hostels, but the Trustees have decided against an extension of the bursary scheme for training men for club leaders and in favour of assisting the National Association of Boys' Clubs to provide a residential institution for standardized training. Another grant of £10,500 was made to the Warwickshire Rural Community Council towards the acquisition, equipment and furnishing of Westham House, Barford, as a Town and Country College to bridge the present and ever-widening gap between townsman and countryman. The Trust has continued to meet the whole cost of maintaining the Irish and Scottish Central Libraries for Students and has maintained its grant in aid of the National Central Library.

The concluding part of the report deals with the plans of the Trust for the quinquennium 1946–50, and a statement of policy forms an inset to the report. The oldest of the major policies of the Trust still extant at the outbreak of war was that of assisting the provision and improvement of village halls. At the date of the review 585 such schemes had been assisted, and the Trustees propose to allocate a further £100,000 for this purpose during the next five years. An allocation of £30,000 for museum services is also proposed, and £150,000 for a comprehensive music and drama policy, to administer which the Carnegie Committee for Music and Drama has been established. While the Trustees are terminating the scheme of making grants in aid of the equipment of local youth clubs, they propose to allocate £40,000 towards the equipment required for residential purposes in youth hostels and camps under detailed conditions, and as an exceptional measure £25,000 has been set aside to help the National Federation of Young Farmers' Clubs to bridge the transitional period between the present system of direct grant from the Ministry of Education and the new system of grants from local education authorities. Provision of a sum of £150,000 is also proposed towards the establishment and maintenance of the Bureau of Current Affairs to provide for the general populace the kind of information service given during the War by the Army Bureau of Current Affairs and the Civil Defence Welfare Services. The inset already mentioned gives the addresses where inquiries regarding particular activities should be made.

Degaussing

The October number of Part 1 of the *Journal of the Institution of Electrical Engineers* (Vol. 93, No. 70) contains three papers which were read at the first session of a symposium on degaussing held during April 4–5, 1946. The first paper, by H. W. K. Kelly, gives a historical survey of developments prior to the start of the campaign against the magnetic mine. The others, by D. H. Parnum and R. J. Gossage, deal respectively with underwater measurements of magnetic field, and the use of ship models, magnetically to scale, in degaussing work.

The November issue of the *Journal* contains four papers on the same subject. The first, by W. C. Potts, surveys the study of the magnetic fields produced by ships constructed during the war period, and indicates, schematically, how degaussing coils were placed for the purpose of neutralization. The electrical engineering aspects of these arrangements are then discussed in detail in a paper by Messrs. I. S. Fraser, A. A. Read and B. E. Vieyra. A further paper, by S. H. Ayliffe, describes alternative measures to that of coiling used as means of affording protection, namely, the processes known as 'wiping', 'flashing' and 'deperming'. The first of these processes was developed mainly for the purpose of providing compensation for the vertical magnetism of those ships which have insufficient power to energize a coil system. That of 'wiping' is based on the principle of magnetizing ferrous materials by stroking with a magnet or current-carrying conductor, and consists in practice of wrapping a cable temporarily around the vessel in the horizontal plane and moving it up and down while a heavy current is passed through it; while that of 'flashing' consists in surrounding the vessel with a horizontal cable near the water line and in passing a heavy current through it momentarily. The term 'deperming' is used to cover any form of treatment, to which the vessel is temporarily subjected, designed to remove or compensate permanent longitudinal or athwartships magnetism. In its final form, the process involved wrapping the hull with a cable solenoid through which short-duration current pulses were passed. Finally, a paper by Messrs. H. C. Wassell and D. A. Turner discusses the effect exercised by degaussing coils on ships' compasses and describes the compass-corrector equipment which was developed. The publications are followed by a summary of the discussion at the Institution and the authors' replies (see also *Nature*, May 18, p. 646).

Metallurgical Research

Vol. 71 (1945) of the *Journal of the Institute of Metals* contains the report of the Council, which shows a total membership of the Institute of 2,686. Twenty-eight original papers are included, together with discussions, and occupy 654 pages. It is of interest to note how large a proportion of the volume deals with the light metals and their alloys, papers on magnesium and aluminium representing about half the total number. Copper and its alloys are dealt with in some half-dozen papers, which include a valuable contribution on the "Computation of Rolling Load, Torque, and Roll-Face Pressure in Metal Strip Rolling" by Dr. M. Cook and E. C. Larke. Three papers refer to the precious metals, while constitutional work (always an important section of the Institute's interests) is dealt with in six. The May Lecture by Sir Thomas Holland dealt with "The Supply of Accessory Metalliferous Minerals", and Dr. R. Seligman discusses "The Organisation of Metallurgical Research". An interesting account is given by Mr. H. A. Sloman of "The Application of the Vacuum-Fusion Method to the Determination of Oxygen, Hydrogen and Nitrogen Contents of Non-Ferrous Metals, Alloys and Powders". The corrosion of metals, as one expects, is dealt with in more than one paper. To those familiar with this *Journal*, all that need be said is, that it fully maintains the high standard of previous issues, a standard which in view of the present difficulties is eminently praiseworthy. The plates, of which there are forty-seven, are excellently produced.

Vol. 12 of "Metallurgical Abstracts" follows the lines which we now expect. 424 pages of abstracts and 88 of indexes give an idea of the care with which the ground is covered. To the metallurgist, both theoretical and practical, as well as to chemists, physicists and engineers, these volumes have become essential.

Test Papers for *p*H Values

We have received from Messrs. Johnson and Sons, Manufacturing Chemists, Ltd., Hendon, London, N.W.4, samples of two kinds of test papers. These are made up in small books like litmus papers. The Universal Test Paper for the measurement of *p*H values provides ten colour matches in steps of 1 *p*H from 1 to 10, with an accuracy of 0·5 *p*H, the appropriate colours being printed inside the covers of each book. The Comparator Test Papers provide a higher degree of accuracy, to 0·3 *p*H, inside narrower ranges, in four kinds from *p*H 3·6 to *p*H 10, the colours being again printed inside the cover. The papers can be dipped into the solution, or the latter applied by a glass rod. We have tested both kinds of papers with buffer solutions and have found the colour changes to be as stated. They should be very useful to chemists, biologists, physicians, and workers in various industries, when a rapid and reasonably accurate method of measuring *p*H is desired. Messrs. Johnson also make a wide range of other test papers and supply a special grade of litmus in the form of granules free from the usual fillings of gypsum or calcium carbonate and requiring only extraction with water to produce an indicator solution. The firm is investigating supplies of lichens from various parts of the world in attempts to produce a high-quality litmus. It is interesting to note that the firm was established so long ago as 1743.

Plant Health in the Argentine

PROF. J. B. MARCHIONATTO has prepared a study of plant health in the Argentine from the colonial period in 1810 down to 1943. (Fac. Agron. y Vet., Univ. Buenos Aires). It is divided into four parts, the first of which is almost entirely historical, giving a description of the development of plant life and also a short account of the work of some of the outstanding men who have devoted their time to this subject. The second part describes the conditions in the Department of Agriculture when Prof. Marchionatto took charge of the Laboratory of Plant Pathology. It also includes a survey of the work that was carried out between 1923 and 1932, when the Division of Phytopathology was formed; Prof. Marchionatto's small laboratory was moved to the new Division, and in 1935 was transferred to the Bureau of Plant Health. Part 3 deals with the organisation of the official services in connexion with the health of plants, the discharge of fiscal duties, the sanitary examination and control of the Department of Agriculture, etc. Part 4 contains an account of progress in the investigation of diseases of plants, and the work and results in the regional laboratories are described.

Government Museum, Trivandrum, Travancore

THE administration report of the Government Museum at Trivandrum for the year 1944–45 is prefaced by statements which imply an unusually strong official confidence in a museum's service. It is somewhat startling to read, for example, that this Museum "has . . . enlarged the minds of the visitors by multiplying their interests, trained their tastes and tended to develop in them an appreciation of the beautiful". Nevertheless, the attendance figures brought forward to support these and other claims certainly indicate a service which is of strong appeal to the people. It is noteworthy that during the year the smallest number of visitors to the Museum on any one day was 589, while the largest number was 12,947. Casts (made by a member of the staff) of sculptures in the temple at Suchindrum are now on exhibition in the Museum; they are described in detail on p. 2 of the report. Dr. J. H. Cousins has prepared a new guide to the Art Museum, which is issued free to visitors, and a small catalogue of the metal images is also available.

Recent Earthquakes

DURING September, nineteen strong earthquakes were registered by the observatories in Switzerland. The earthquake of September 10 had its epicentre near V. Camonica in the Italian Alps; that of September 12 in the Shansi province of China, and those of September 29 and 30 in the Solomon Islands and Peru respectively. During October, fifteen strong earthquakes were registered in Switzerland. That of October 23 occurred in the Karnische Alps near Trieste, and that of October 30 in the Aleutian Islands. During the first half of November, there were six strong earthquakes in various parts of the globe. That of November 1 occurred in the Aleutian Islands and that of November 2 was destructive in the Uzbeck and Kirghiz districts of the U.S.S.R. The earthquake of November 3 had its epicentre approximately on the equator at long. 17° W., whereas that of November 4 had its epicentre near lat. 40° W., long. 53·5° E. near the Caspian Sea. Epicentres of the above earthquakes in November have been obtained, using instrumental reports from observatories, by the U.S. Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, as well as by the International Seismological Office at Strasbourg. The U.S. Coast and Geodetic Survey has also determined the epicentres of the earthquakes of November 10 and 12. The former was destructive near Sihuas, about 225 miles north of Lima in Peru, and the latter occurred near lat. 21° S., long. 173° W.

Economic Reconstruction in Great Britain

THE Council of the Royal Society of Arts has decided to devote eight of the remaining ordinary meetings during the present session to a series of eight lectures, dealing with various aspects of economic reconstruction in Great Britain. The lectures will be given at the Society's House in John Adam Street, Adelphi, London, at 5 o'clock, on Wednesdays, the first being on January 15, and will be followed in all cases by an open discussion. The topics to be dealt with include the relation of Britain to the world trade situation, scientific approach to labour problems, materials, finance, craftsmanship, production, distribution and economics.

Announcements

MR. W. C. F. HESSENBERG, chief officer of the Liaison Department of the British Non-Ferrous Metals Research Association, has been appointed head of the Mechanical Working Division of the British Iron and Steel Research Association, and will take up his new post in a few months time.

IT is announced by British Drug Houses, Ltd., that Dr. F. Hartley, Dr. C. Ockrent, Mr. H. G. Rolfe and Mr. G. F. Williams have joined the board of the company. Dr. F. H. Carr and Mr. R. R. Bennett have retired from active participation in executive work, but Dr. Carr will continue as chairman of the company and Mr. Bennett as director.

ERRATUM.—Miss Mariam George, writing with reference to the communication "Synergic Action of Penicillin and Bacteriostatic Dyes" (*Nature*, November 16, 1946, p. 709), states that in the two tables, the minimum inhibiting concentration of dyes should be $\frac{1}{1\cdot75} \times 10^{-6}$, $\frac{1}{2} \times 10^{-4}$, etc., instead of $1\cdot75 \times 10^{-6}$, 2×10^{-4}, etc.

LETTERS TO THE EDITORS

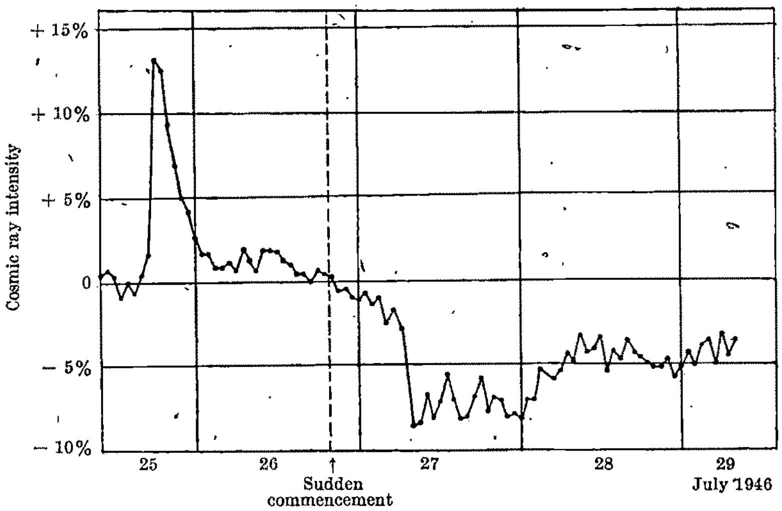
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Cosmic Ray Intensity at Manchester and Solar Disturbances of July 25, 1946

RECENT correspondence in *Nature*[1,2,3] has directed attention to phenomena connected with the great sunspot and solar flare of July 25, 1946, onwards, including a large increase in solar noise and a great geomagnetic disturbance.

The accompanying figure shows a cosmic ray disturbance which was recorded in Manchester at this time. The amplitude of the positive-going peak of about 13 per cent above normal hourly rate makes this disturbance unusual.

Three independent intensity recorders are in operation at Manchester, and the main features of the storm were reproduced in each. Two of them count at the rate of 65,000 three-fold coincidences per hour, and the third at the rate of 30,000 two-fold coincidences per hour. As the hourly rates for the first two were for the intervals 16 hr.–17 hr., etc., and for the third recorder for the intervals 16.30–17.30, etc., it is possible to deduce half-hourly rates for the rise of the peak. This gives the maximum as occurring between 18.00 and 18.30 G.M.T., and of amplitude 17 per cent above the normal half-hourly rate.



According to detailed information kindly supplied by the Astronomer Royal, the magnetic disturbance had ceased by about 10 hr. on July 27. At this time, however, the cosmic ray intensity was still about 8 per cent below normal. A very slow recovery, as usual, resulted in more than a week elapsing before the pre-storm level was regained.

No unusual effect was recorded in Manchester corresponding to that reported from Lahore[4].

The only previously reported peaks appear to have been those associated with the cosmic ray storm of February 28–March 10, 1942. An amplitude of about 8 per cent above normal bi-hourly rate was measured for each of the two peaks that occurred then[5,6].

On these two occasions, when sudden increases in cosmic ray intensity have been recorded, they have occurred some hours before the commencement of the magnetic disturbance. This period was 17 hours for the 1942 storm[5] and 25 hours for the 1946 storm considered here.

D. W. N. DOLBEAR
H. ELLIOT

Physical Laboratories,
The University, Manchester 13.
Nov. 25.

[1] Ellison, M. A., *Nature*, **158**, 160 (1946).
[2] Ellison, M. A., *Nature*, **158**, 450 (1946).
[3] Lovell, A. C. B., and Banwell, C. J., *Nature*, **158**, 517 (1946).
[4] Sarna, H. R., and Sharma, O. P., *Nature*, **158**, 550 (1946).
[5] Lange, I., and Forbush, S. E., *Terr. Mag.*, **47**, 331 (1942).
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Measurements of Changes of the Phase-Paths of Radio Waves in the Ionosphere

MEASUREMENTS of the heights of reflexion of short radio waves returned from the ionosphere have usually been restricted to measurements of the 'group' or 'equivalent' path travelled by the waves. The group path, P', is given by

$$P' = c\int_{\text{path}} \frac{ds}{U}, \quad . \quad . \quad . \quad . \quad (1)$$

where U is the group velocity of the waves over the distance ds. Measurements of P' are most easily made by pulse methods. It is possible also to define the 'optical' or 'phase' path of a wave by

$$P = c\int_{\text{path}} \frac{ds}{V}, \quad . \quad . \quad . \quad . \quad (2)$$

where V is the phase or wave-velocity of the wave over the distance ds.

Several authors[1] have described modifications of the pulse technique whereby changes of phase-path may be measured, but these methods do not provide a means of distinguishing between an increase and a decrease of phase-path. Appleton[2] has described how the frequency-change method may measure both the rate of change of phase-path and the sense of the change. The purpose of the present note is to describe a modification of the pulse method, which allows of the determination of both the magnitude and the sense of a change of phase-path.

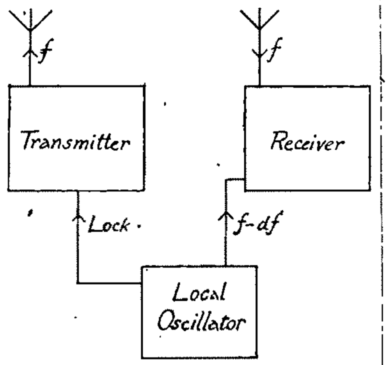

Fig. 1. BLOCK DIAGRAM OF THE METHOD USED FOR DETECTING CHANGES OF PHASE-PATH

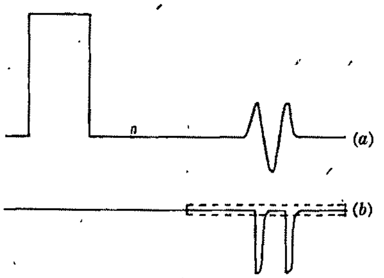

Fig. 2. (a) THE FORM OF AN ECHO RETURNED FROM THE IONOSPHERE BEATING WITH THE LOCAL OSCILLATOR. (b) MODIFIED FORM OF (a)

The usual arrangement of a transmitter which emits a regular succession of pulses is used. These pulses are received and displayed on a linear time-base which is synchronized with the emission of the pulses. This arrangement is modified, as is shown in block form in Fig. 1. A local oscillator injects a signal of frequency about 15 kc./sec. less than the frequency of the transmitter, through an attenuator, into the first circuit of the receiver. The local oscillator is started by the same pulse that starts the transmitter; but the oscillator then continues to oscillate for about 10 millisec., while the transmitted pulse lasts for only 150 microsec. This method of starting the local oscillator and the transmitter ensures that the radio-frequency oscillations in each start in the same phase.

The down-coming pulse from the ionosphere arrives at the receiver together with the signal from the local oscillator, and the two beat together, since they differ in frequency. The amplitude of the signal injected from the local oscillator is adjusted by the attenuator to be always about the same as that of the down-coming pulse. The beat frequency is displayed on the linear time-base, where it has the appearance shown in Fig. 2 (a). If the phase-path of the wave which travels to the ionosphere is constant, then the pattern remains stationary on the time-base. If the phase-path increases by one wave-length of the transmitted frequency, the pattern moves to the right by a distance equal to the distance between successive crests of the pattern. If the phase-path decreases by one wave-length of the transmitted frequency, the pattern moves to the left by a distance equal to the distance between successive crests of the pattern.

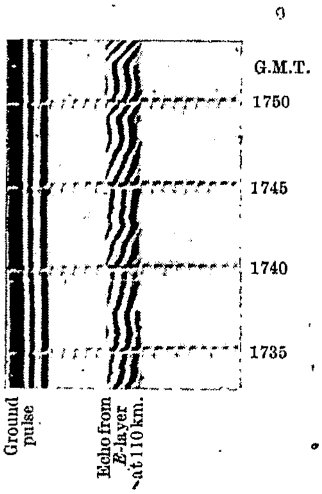

Fig. 3

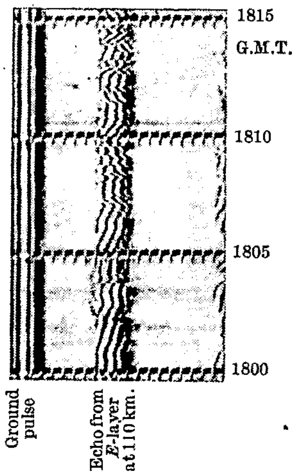

Fig. 4

Fig. 3. SPECIMEN RECORD OBTAINED FROM THE E-REGION OF THE IONOSPHERE, WHEN THE REGION IS 'QUIET'

Fig. 4. SPECIMEN RECORD OBTAINED FROM THE E-REGION OF THE IONOSPHERE, WHEN THE REGION IS 'DISTURBED'

To enable the total change of phase-path to be recorded, the pattern of Fig. 2(a) is transformed by electrical means into that of Fig. 2(b). This trace is then photographed through a slit on to a strip of paper which moves perpendicularly to the trace at a constant speed. The type of record obtained is shown in Fig. 3. Decreases of phase-path of one wave-length appear as white lines sloping downwards from left to right; increases appear as white lines sloping upwards from left to right. The total change of phase-path is obtained by counting the number of wave-lengths by which the path changes, and multiplying this number by the wave-length of the transmitter.

This method has been used to study the changes of phase-path of pulses returned from the E- and the F-layers of the ionosphere. Wave-lengths of 150 metres and 75 metres have been used. Although the method is sensitive to changes of path of less than one wave-length, the accuracy is, in fact, limited by the stability of the frequency of the transmitter and of the local oscillator. At present, changes of path which occur in a few minutes can be measured to an accuracy better than 100 metres.

On twenty occasions during the observations of pulses returned from the E region, Dellinger fade-outs have occurred. In all these occurrences, the start of the fadeout has been marked by a rapid reduction of phase-path, taking place in about a minute, and being of the order of one kilometre in size. The recovery of the echo after the fade-out has been associated with a slower increase of phase-path, usually of the same size as the initial decrease.

One possible explanation of this change of phase-path is that it is caused by the change in phase-velocity of the radio waves in the region causing the increased absorption of echoes during the fadeout. If this explanation is adopted, and if the change in echo amplitude associated with the change in phase-path is known, it is possible to estimate the collisional frequency of the electrons with the neutral atoms in the region causing the fade-out. Values for this quantity for the twenty fade-outs vary from $1\cdot6 \times 10^5$ per sec. to $5\cdot5 \times 10^5$ per sec., with a mean value of $3\cdot6 \times 10^5$ per sec.

The behaviour of region E is not always such as to give the record of changes of phase-path illustrated in Fig. 3. Such records are generally obtained when the region is 'quiet' in the sense used by Best, Farmer and Ratcliffe[3]. When the region is 'disturbed' the type of record shown in Fig. 4 is obtained. The echo fades and shows discontinuous changes of phase-path. Sometimes parts of the echo show very different rates of change of phase-path from the rest. Qualitatively these results could be explained by the E region, when disturbed, having local irregularities in ionization density.

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[1] Hafstead and Tuve, *Proc. Inst. Rad. Eng.*, (2), **17**, 1786 (1929). Ranzi, *Nature*, **132**, 174 (1933).

[2] Appleton, *Proc. Phys. Soc. Lond.*, **42**, 321 (1930); *Proc. Roy. Soc.*, A, **126**, 548 (1930).

[3] Best, Farmer and Ratcliffe, *Proc. Roy. Soc.*, A, **164**, 96 (1938).

Relativistic Wave Equations

DIRAC'S wave equation of a free electron may be expressed in the form

$$(i\alpha_\mu\partial^\mu + \chi)\,\psi = 0, \quad . \quad . \quad . \quad (1)$$

where the matrices α_μ ($\mu = 0, 1, 2, 3$) obey the commutation relations

$$\alpha_\mu\alpha_\nu + \alpha_\nu\alpha_\mu = 2g_{\mu\nu}. \quad . \quad . \quad . \quad (2)$$

The usual notation is used, and $g_{\mu\nu}$ is the metric tensor for flat space-time given by $g_{00} = 1$, $g_{11} = g_{22} = g_{33} = -1$, the other components vanishing. The commutation relations (2) are such that from the first-order equation (1) one may deduce the second-order equation

$$(\partial_\mu\partial^\mu + \chi^2)\,\psi = 0. \quad . \quad . \quad . \quad (3)$$

In Kemmer's theory of the meson there are used certain matrices β_μ ($\mu = 0, 1, 2, 3$) which satisfy the commutation relations

$$\beta_\mu\beta_\nu\beta_\rho + \beta_\rho\beta_\nu\beta_\mu = g_{\nu\rho}\beta_\mu + g_{\mu\nu}\beta_\rho, \quad . \quad (4)$$

which ensure that the first-order equation

$$(i\beta_\mu\partial^\mu + \chi)\,\psi = 0$$

is consistent with the second-order equation (3).

The relations (4) are not symmetrical in all the suffixes, unlike in (2) where there is complete symmetry. Let us suppose that there exist $\varepsilon_\mu(\mu = 0, 1, 2, 3)$ which satisfy the symmetrical relations

$$(\varepsilon_\mu\varepsilon_\nu + \varepsilon_\nu\varepsilon_\mu - 2g_{\mu\nu})\varepsilon_\rho + (\varepsilon_\nu\varepsilon_\rho + \varepsilon_\rho\varepsilon_\nu - 2g_{\rho\nu})\,\varepsilon_\mu + (\varepsilon_\rho\varepsilon_\mu + \varepsilon_\mu\varepsilon_\rho - 2g_{\mu\rho})\varepsilon_\nu = 0. \quad (5)$$

It is readily seen that α_μ and β_μ both satisfy (5). That is, the matrices α_μ and β_μ are possible representations of ε_μ. It would be of interest to see if, apart from α_μ and β_μ, there exist other representations of ε_μ, and if so whether they may be used to formulate a theory of particles. If we assume for a moment that a representation of ε_μ exists, we should then see whether the commutation relations satisfied by ε_μ are such that the first-order equation

$$(i\varepsilon_\mu\partial^\mu + \chi)\,\psi = 0, \quad . \quad . \quad . \quad (6)$$

leads to the second-order equation (3). It is easy to show that the commutation relations (5) satisfy this requirement. We operate on (6) from the right by $(\varepsilon_\nu\varepsilon_\rho + \varepsilon_\rho\varepsilon_\nu)\,\partial^\nu\partial^\rho$, and use (5). Then from (6) we obtain $\chi(\partial_\mu\partial^\mu + \chi^2)\,\psi = 0$, which is equivalent to (3) when χ is not zero.

Now we come to the question of the representations of ε_μ. So far as I am aware, the possible general representations of ε_μ given by (5) have not been investigated. It appears to me likely that the general relations (5) alone may not be sufficient to ensure a finite representation. More stringent requirements may be necessary. These extra conditions should be consistent with (5) and also should be relativistically invariant. Examples of such conditions are (2) and (4), which give the known representations α_μ and β_μ respectively. It is not impossible that there may be other conditions which give new representations of ε_μ different from α_μ and β_μ.

This question is being investigated further and will be dealt with in a later communication.

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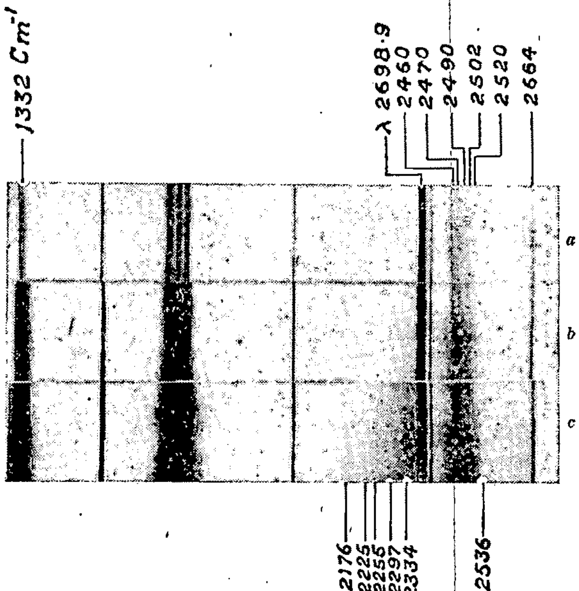
Raman Spectrum of Diamond under High Resolution

USING the λ 2536·5 radiation of the mercury arc as the exciter and a Hilger 'Intermediate' quartz spectrograph, the faint second-order Raman spectrum of diamond was first successfully recorded by me[1]. Later investigations[2,3] with somewhat larger diamonds and with a more powerful instrument, namely, a Hilger 'medium' quartz spectrograph, resulted in a notable improvement in the clarity of the recorded spectra. I have now succeeded in obtaining a satisfactorily exposed picture with a 'large' Hilger quartz spectrograph. The expectation that the greater dispersion and resolution given by this instrument would enable the true nature of the spectrum to be exhibited unambiguously has been fulfilled. Three prints of varying depth enlarged from the original spectrogram are reproduced herewith. The principal feature noticeable in the spectra is the appearance of a whole series of sharply defined Raman lines clearly resolved from each other. Twelve of the most prominent of these lines have been marked with their respective frequency shifts in wave-numbers from the exciting radiation. The width of the individual Raman lines, as is evident from a comparison with the lines of the mercury arc, is no greater than that arising from the instrumental and photographic factors. Besides those marked, there are other fainter lines just discernible in the spectrogram against a fainter unresolved background of apparently continuous spectrum.



The experimental results shown in the spectra are obviously of great interest in relation to the fundamental problem of the nature of the vibration spectrum of a crystal lattice. The largest observed frequency shift in the second-order spectrum, namely, 2664, is clearly the octave of 1332 appearing strongly in the first order. This suggests that all the other lines observed in the second-order Raman effect are likewise either octaves or else allowed combinations of discrete vibration frequencies of the crystal lattice which are Raman-inactive in the first order. This interpretation is supported by a large body of experimental evidence, for a detailed discussion of which reference should be made to some recent papers[3,4,5].

The main point which emerges from the experimental facts now established is that the vibration spectrum of the diamond lattice in the infra-red region is a discrete one made up of a finite set of monochromatic frequencies. Combinations of these with the non-discrete or continuous spectrum of elastic-solid vibrations in the lower range of frequency would account for the fainter unresolved background observed in the recorded spectra.

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'Thermal Wedge' Theory of the Parallel Surface Thrust Bearing

Messrs. M. C. Shaw and C. D. Strang[1] have criticized the 'thermal wedge' explanation of the parallel surface thrust bearing put forward by A. Fogg in his paper[2] describing his experimental work.

A mathematical treatment of this bearing has been made using the 'thermal wedge' idea, that is, the equation of continuity becomes

$$\frac{\partial}{\partial x}[(1-\gamma\theta)q_x] + \frac{\partial}{\partial y}[(1-\gamma\theta)q_y] = 0,$$

where q_x, q_y are the rates of flow in the x and y directions and the density $\rho = \rho_1(1-\gamma\theta)$, where ρ_1 is the inlet density, θ the rise of temperature from the inlet and γ the factor of proportionality. This paper will be published in due course in the *Proceedings of the Sixth International Congress of Applied Mechanics*. As all the heat in this theory was assumed to be carried away by the oil, the figures produced for the coefficient of friction were too low. It is hoped in a subsequent paper to give the extended theory with viscosity varying across the thickness of the film and heat loss by conduction as well as convection.

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[1] Shaw, M. C., and Strang, C. D., *Nature*, **158**, 452 (1946).

[2] Fogg, A., *J. Inst. Mech. Eng.* (Jan. 1945).

Transport of Heat and Other Properties by Atmospheric Turbulence

THE theory of the turbulent transfer of heat in the atmosphere, based on the concept of the 'mixing length', was introduced by G. I. Taylor[1] in 1915. Modified by D. Brunt[2] to be applicable to a compressible atmosphere, the theory requires that the flow of heat is in the direction of the gradient of potential temperature, and thus is normally downward. From these treatments a close analogy can be drawn between molecular transfer and the larger scale of eddy transfer.

There is, however, a distinct difference between these two mechanisms of transfer for any property the distribution of which itself affects the flow, for example, through the action of buoyancy forces. The possible consequences of this difference with reference to heat transfer in the atmosphere are discussed in a paper which will be published elsewhere.

In this paper it is shown that a component of heat flux, for which the name 'convective turbulence' is suggested, must result from the buoyancy forces. This is always directed upwards, and is thus in general opposed to the downward transfer by mechanical turbulence.

Records of the fluctuations in temperature at fixed levels up to 6,000 ft. which have been made at Cardington with a sensitive quick-response thermometer confirm the importance of convective turbulence, and show that it may at times completely dominate the heat flow. This conclusion is supported by consideration of the heat interchange between the air and the ground over short periods of time in certain types of weather situations. Furthermore, the heat flux due to convective turbulence estimated from the temperature traces on these occasions is sufficient to maintain the interchange of heat between the air and the ground.

Convective turbulence has further important applications in helping to explain the increase of potential temperature with height in the troposphere, and the temperature distribution in the stratosphere.

Although the work which has been done so far is concerned only with the transfer of heat, the distinction between eddy and molecular processes has important applications in the transfer of other properties, for example, water and dust content in the atmosphere, salinity of the ocean and possibly momentum.

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[1] Taylor, G. I., *Phil. Trans. Roy. Soc.*, A, **215** (1915).

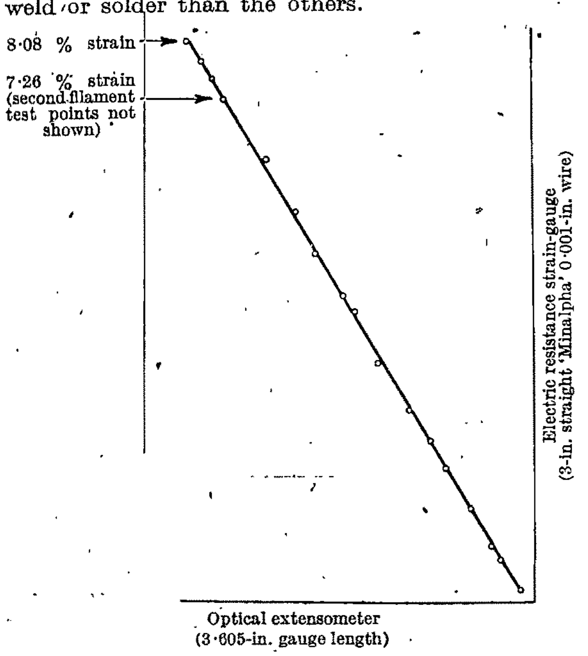
[2] Brunt, D., *Proc. Roy. Soc.*, A, **124** (1929).

Electrical Resistance Wire Strain-Gauges to Measure Large Strains

I WISH to direct attention to the performance of 'Minalpha' wire as supplied by Johnson Matthey when used as the filament in an electrical resistance wire strain-gauge, and also to indicate the effect of the connexion between the filament wire and the stout wire used to connect it to the measuring bridge.

This type of strain-measuring gauge uses a very fine metal filament (50 gm. 0·001-in. diameter is usual) stuck to a paper base with cellulose cement. The paper, which acts as the insulator for the filament, is stuck to the surface on which the strain is to be measured. As the filament wire is strained, its electrical resistance changes and is measured on a suitable bridge. Calibration of the resistance change gives a measure of the strain.

I wished to find a material and the conditions necessary for satisfactory operation of gauges at large strains. A lightly stretched strip of condenser tissue was hung vertically, and then the various 0·001-in. diameter wires, each with a tension of about 2 gm., were hung in front of it. 'Durofix', diluted one-to-one with butyl acetate, was used to stick the wires to the paper. The paper had been prepared with flapped holes through which the stout connecting wires could be soft-soldered or spot-welded to the fine filaments. All gauges used were made in one strip in this manner to ensure that they were as nearly similar as possible. The filaments were in pairs of the same material. One filament of each pair was $2\frac{3}{4}$ in. between the outside circuit connecting wire joints, whereas the other one was $3\frac{1}{4}$ in. between connexions. Bending the paper base along transverse lines 3 in. apart and between the joints ensured that the joint connexions of one filament would be strained while those of the other filament would be unstrained after cementing to the specimen and loading. Thus the strain performance of each material with and without a joint under strain could be studied. Each paper had three materials—two commercial copper-nickel alloys and 'Minalpha'—and thus held six gauges. On the flat simple tensile specimen used, one such group of gauges was used on each face. Cementing was with dilute 'Durofix'. 'Minalpha' was found to have the best working properties because it stayed straight, whereas the other two wires curled up like 'fuzzy' hair when unreeled without any tension on the free end. Also 'Minalpha' is slightly easier to weld or solder than the others.



As regards the relative performance of the materials and types of construction in connexion with the maximum strain at which the gauge still operated, it was found that for a given material the strain range is doubled by not straining the joint between the filament and the connecting wire. Again, broadly, on these tests at least, 'Minalpha' has double the strain range of the other materials. Thus by using 'Minalpha' wire with an unstrained joint, the strain range of electrical resistance wire strain-gauges may be increased about four times the best available hitherto, since they have been made with a strained joint. This may be seen as a considerable step forward in British electric resistance wire strain-gauge practice, which until recently used nichrome wire with an ultimate strain less than 0·6 per cent, whereas 'Minalpha' operates up to 7–8 per cent strain.

The remarkable linearity of 'Minalpha' electrical strain measurement against optical strain measurement right up to open circuit of the filament is illustrated by the graph. The material is adequately sensitive for use in the small strains range at which these gauges are frequently used. A provisional patent specification has been filed.

Clearly, further work must be done to examine the consistency of performance of 'Minalpha', since only two pairs of gauges have been tested up to the present. However, the present results may stimulate manufacturers and research workers to do further work. My research on post-yield stress and strain causes me to regard gauges as a tool and not as a line of research; but I shall be glad to hear of the experiences of others in this field.

The consequence of finding that 'Minalpha' has such a large strain range is that now strain measurements can be made from zero upwards, since comparator methods, such as photo-grid, can take over when the electric gauge breaks. I can now undertake accurate examination of my post-yield stress-strain theory[1].

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[1] *Phil. Mag.*, vii, 36, 443 (1945).

Hybridization in the Methyl Radical of CH_3X Molecules

IN order to interpret the anomalous dipole moments observed in methyl halides, Mulliken[1] has assumed that the *s,p* hybridization of the carbon atom is modified in the different compounds.

Recently, de Hemptinne and Doehard[2] have recorded the Raman spectra of deuterated methyl halides and methyl alcohol in the liquid state. On the basis of certain frequencies assigned to some of the normal modes of these molecules, they have computed the magnitude of others very accurately. This indicates that the form of the potential function is adequately chosen, and makes it practically certain that the numerical values of the force constants given below are correct.

We summarize in the accompanying table the results obtained by these authors, and we include those obtained by us for methyl thiol[3]. The values given for the latter are probably less accurate than the others. But the fact that we have used the same type of potential function makes such a comparison possible.

The symbols for the force constants and distances used in this table are those adopted by de Hemptinne and Doehard. The units are respectively 10^5 dynes and angströms.

		f_{CX}	f_{CH}	d_{CX}	d_{CH}	k	S_{CX}	S_{CH}	
I	CH_3Cl	3·30	4·89	0·240	0·436	0·406	1·71	1·093	72° 30′
	CH_3Br	2·75	4·93	0·174	0·430	0·340	1·90	1·093	72° 30′
	CH_3I	2·28	4·96	0·114	0·429	0·301	2·20	1·093	72° 30′
II	CH_3OH	4·92	4·68	0·432	0·436	0·412	1·43	1·093	72° 30′
	CH_3SH	3·65	4·73	0·360	0·430	0·573	1·82	1·1	72° 30′

Certain features of these results are sufficiently striking to merit special attention. They concern particularly the behaviour of the valency force constant f_{CH} and of the bending force constant d_{CH}.

The former increases by about six per cent with decreasing electronegativity of the adjacent atom, whereas the latter decreases by about one and a half per cent in both groups of compounds[4]. If the decreasing electronegativity is responsible for this effect and tends therefore to strengthen the CH bond, it would be expected that the CH force constant in

CH_4 would be an upper limit for compounds like CH_3X. The value 5·04 given by Herzberg[5] is in agreement with this point of view.

These systematic deviations of the force constants in the CH_3 group could be partly explained by assuming that the changes of electronegativity of the adjacent atom produces changes in the hybridization of the *s* and *p* orbitals of the carbon atom. If so, the fact that d_{CH} decreases with the electronegativity, which implies a greater amount of *s* orbital in the same way, proves that the strengthening of CH is due to the increasing of the *s* orbital in CH_3 and, therefore, of the *p* orbital in C—*X*. This is exactly the hypothesis reached by Mulliken in another way. Our development gives a new and direct support to this hypothesis, which is now extended to alcohols and thiols. It should be noted that the substitution of bromine for one hydrogen in methane lowers the CH bond energy by about 2–3 per cent[6]. The parallelism with the change of the valency force constants is particularly impressive. Furthermore, Penney[7] has shown how the structure of CH_3X compounds is modified by the ratio of mixing *s*—*p* of the carbon atom. In taking into account the fact that *s* increases in CH_3 from CH_3F to CH_3I, one finds immediately that CH_3 tends to become more plane with increasing electronegativity. In regard to the slight changes of hybridization indicated by the above results, we may expect only small but regular deviations from the tetrahedral angle in the series of CH_3X compounds. The ionic character of the carbon-halogen link must also be considered and tends to favour similar deviations, as shown by Penney[7]. Unfortunately, even now the experimental data are not known with sufficient accuracy to test these conclusions. However, we believe that there may be deviations of some degrees.

Nevertheless, a more exact knowledge of the molecular structure is needed to explain the surprising discrepancies between the small changes of hybridization and the considerable perturbations observed in the behaviour of the dipole moments, in particular the large moments of CH_3I (1·59 *D.*) and CH_3SH ($\sim$ 1·39 *D.*). The selectivity effect of the increasing electronegativity on the *s* orbital should also be cleared up.

It is perhaps worth while pointing out that such a small effect could play an important part in chemical reactions with low activation energies, in particular in biochemical processes. Furthermore, its influence should also be emphasized in the derivatives of conjugated systems. However, further theoretical investigations would be needed for such an extension of our development which, up to the present, can be applied only to carbon atoms in the sp^3 condition.

I am very much indebted to Dr. C. A. Coulson for discussions on certain points.

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[1] Mulliken, R. S., *J. Phys. Chem.*, **41**, 318 (1937).

[2] de Hemptinne, M., *Trans. Farad. Soc.*, **52**, 5 (1946). de Hemptinne, M., and Doehard, Th., *Bull. Acad. Roy. Belg.*, **29**, 447 (1943); **29**, 783 (1943); **30**, 189 (1944); **30**, 447 (1944).

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Function of Volutin (Metaphosphate) in Mitosis

VOLUTIN is a cytological entity which has long been recognized as an important constituent of the yeast cell. After fixation with formaldehyde and over-staining with methylene blue, it retains the stain when treated with dilute acids. I have devised a staining mixture which makes volutin directly visible in yeast cells; it contains 1·5 c.c. of glacial acetic acid, 4 c.c. of saturated aqueous toluidine blue and 20 c.c. of formalin. Volutin does not contain nucleic acid; ribose nucleic acid granules in the cytoplasm are often referred to as 'volutin', but this is incorrect[1]. Wiame[2] has defined volutin chemically as metaphosphate, thus confirming my view that it is not a nucleoprotein.

The volutin-rich structures in the vacuole of the yeast cell have been identified as chromosomes by their structure and behaviour; they are paired, there is a maximum of twelve of these bodies in each vacuole, and their mitotic division occurs without a visible spindle. It is not possible to find chromosomes regularly in every cell of all preparations. However, I have determined (independently of Wiame) the conditions controlling the appearance and disappearance of volutin. They are as follows: most non-dividing preparations contain volutin in only a few cells (*Torulopsis utilis* is a conspicuous exception to this rule, for its cells retain a considerable amount of volutin at all times). From a few minutes to several hours after non-dividing cells have been placed in an adequate nutrient, containing sources of nitrogen, carbohydrate, and accessory substances, every cell will contain enormous volutin chromosomes in the vacuole, depending on the aeration and the specific culture. As division proceeds the amount of volutin diminishes; in rapidly growing cultures on poor medium the volutin may disappear from the chromosomes of nearly every cell. If the culture is growing rapidly in a very good medium, volutin may be visible on the chromosomes throughout the period of division. Cultures differ in the speed with which volutin disappears, but this may occur shortly after growth ceases in a very rapidly dividing, well-aerated culture. These rules hold for several *Schizosaccharomyces* and *Saccharomycodes* tested, as well as for different species of *Saccharomyces*. *Torulopsis utilis* rarely loses all its volutin, while *T. datilla* loses it readily.

In my earlier paper on yeast chromosomes[1], it was concluded that they were composed of volutin instead of desoxyribose nucleoprotein. Rafalko[3] has since shown that the yeast chromosomes contain desoxyribose nucleic acid and are apparently conventional in this regard. There is another well-recognized desoxyribose nucleoprotein body in the yeast cell. This is the centriolar body which is attached to the outer wall of the nuclear membrane. Lindegren and Lindegren[4] have proposed that the desoxyribose nucleoprotein in the centriole is the equivalent of the heterochromatin in cells of higher organisms, while the vacuolar chromosomes are composed of euchromatin.

The present data indicate that volutin coats the euchromatic chromosome previous to division. This suggests that volutin (metaphosphate) is essential for division, and that only chromosomes coated with volutin are capable of division. This is consistent with Wiame's view that metaphosphate may be a source of energy through its content of energy-rich phosphate bonds. Once volutin has been metabolized, it must be replaced before the chromosome can divide again. Since the cells of many cultures lose their volutin after division ceases, a lag period occurs when dissimilated cells are introduced into a fresh medium.

When spores are produced, volutin appears in the epiplasm. This may be explained by assuming that volutin is formed in the cytoplasm of normal vegetative cells when adequate nutrients are available, and passes through the nuclear membrane into the vacuole, where it is deposited on the chromosomes. When the cytoplasm is cut off from the nuclear vacuole by the spore wall, volutin accumulates in the epiplasm.

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Synthesis of Cellulose by Resting Cells of *Acetobacter xylinum*

IN plants, cellulose is formed intracellularly, by a process the chemistry of which is completely unknown. Microscopic evidence adduced by Farr suggests that the conditions of cellulose formation in green plants are very complex[1,2]. But in cultures of the bacterium *Acetobacter xylinum*, true cellulose[3,4,5,6] in the form of a mesh of beautifully defined microscopic fibrils occurs as an extracellular product[7,8]. In view of the success which has attended application of bacterial tools to the elucidation of the mechanism of biosynthesis of several polysaccharides[9,10], employment of *A. xylinum* in the study of the mechanism of cellulose formation would seem to be an obvious consideration.

An overwhelming majority of cells in a culture of *A. xylinum* lies immobilized within the tough cellulose pellicle which covers the surface of the fluid. The cells are held tenaciously by this matrix, and they are, therefore, difficult to prepare by usual methods in the form of a free cell suspension. Study of the metabolism of *A. xylinum*, and in particular of the enzymes which enable it to convert an impressive range of substrates[11,12] into cellulose, has been hindered by this circumstance. Recently, however, a method has been found for the conversion of the *A. xylinum* pellicle into a colloidal suspension of cellulose fibrils and cells[8]. It has been found that if this product is run through a cheese-cloth, the latter retains the fibrils but the bacteria pass. A means of obtaining metabolically active cellulose-free cells in good yield from young *xylinum* pellicles is thus afforded. Washed cell suspensions obtained in this way can be stored in a refrigerator for several days without noticeable loss of activity.

When the washed fibril-free cells are added in a high concentration to a solution of glucose (2 per cent) in phosphate-buffer (*m*/60) of *p*H 5·0 and the mixture is allowed to stand undisturbed in a thin layer (2 mm.) at 37° C. in a Petri dish, a striking reaction can be observed: after about an hour, macroscopic thread-like formations appear; after 2–4 hours, the turbidity of the fluid is reduced, the threads are no longer visible, and instead the bottom of the dish is overlain by a coherent membrane which presents the consistency of a slimy gel. This reaction does not occur in absence of added substrate (glucose).

Under the microscope, the formed gel is seen to consist of a hyaline matrix within which lie numerous bacteria. Treatment of the material with hot 1 per cent sodium hydroxide dissolves the bacteria but not the extracellular matrix. The latter is recovered after the treatment with alkali in the form of a colourless soft translucent mass. The properties of this material (staining reactions, solubility, chemical composition) are those of a cellulose. At the temperature (37° C.) of this experiment, *A. xylinum* completely fails to multiply even in an optimal nutrient solution. Both from this and other reasons it follows that in the conditions described glucose is polymerized to extracellular cellulose in entire absence of cell proliferation.

The ability of the resting cells rapidly to form cellulose in a medium of defined simple composition is by no means limited to the case of glucose substrate. Cells suspended in phosphate buffer formed coherent cellulose membranes within a few hours from fructose, mannitol, and sorbitol, as well as from glucose. In 20 hours they formed membranes also from the following: glycerol, galactose, lactose, sucrose and maltose. In the same conditions the cells completely failed to form a membrane from any of the following: sorbose, mannose, cellobiose (!), erythritol, ethanol and acetate. Since *A. xylinum* oxidizes mannitol to fructose, it is simplest to suppose that this product is a primary intermediary of cellulose formation from mannitol. In the case of sorbitol, on the other hand, it is evident that the reaction of cellulose production must follow a path other than that of oxidation of a C_2 group, since it has been shown that sorbose itself does not serve as a substrate of membrane formation.

In connexion with these experiments, the effect of baker's yeast on the process of cellulose formation from polyhydric alcohols is instructive. Baker's yeast, as expected, completely prevented accumulation of fructose in the mannitol solution but not accumulation of sorbose in sorbitol solution; yet, surprisingly, failed in both cases to inhibit membrane production from either of the alcohols. It follows that the process of cellulose production in these cases does not involve any fermentable sugar molecules in the external medium of the cells. It is logical that the large fully formed cellulose entity cannot pass through the cell membrane. Thus it becomes necessary to postulate at least two distinct steps in cellulose production: an intracellular step in which a precursor (possibly a glucosan) of relatively low weight is formed, and an intercellular step in which the high polymer is produced.

Some properties of the overall reaction may be noted briefly. The reaction optimum is found to be at about *p*H 5·5. The reaction-rate varies in the usual way with substrate concentration, and, within limits, with the cell concentration. Oxygen is essential to the realization of the polymerization, since the cells fail in a nitrogen atmosphere to form a coherent membrane. The dependence on oxidation is further demonstrated by the finding that poisons (cyanide, azide) which inhibit respiration by *A. xylinum* suppress already in low concentration formation of the cellulose membrane. Fluoride, too, inhibits the reaction, but does so apparently by a different mechanism, since it markedly depresses cellulose production even at a concentration (*m*/100) in which it does not affect the respiration-rate. It should be noted that the reaction of cellulose production is independent of the specific addition of phosphate to the medium of the cells; but this does not, of course, exclude the possibility that the synthesis is dependent on intracellular presence of phosphate.

It is intended to discuss implications of these findings for the mechanism of cellulose biosynthesis at a future opportunity. Because cellulose production is linked with respiration, the possibility is being further examined whether similar energy transfer systems are involved in production of cellulose, as in production of starch or glycogen from plain glucose.

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Vitamin C in English Apples

THE restrictions in the national diet during recent years have encouraged the search for foodstuffs rich in particular nutrients, and considerable attention has been paid to sources of vitamin C. But while many rare or unusual fruits and plants have been examined, the typical English fruit, the apple, has been practically neglected. For it has been generally assumed that most varieties, with the exception of Bramley's Seedling, are very poor sources of the vitamin. For example, the value given by the Medical Research Council tables[1] is only 5 mgm. ascorbic acid/100 gm. of edible tissue. The tables of Fixen and Roscoe[2], however, quote values lying within the wide range 0·1–31·8 mgm./100 gm., and even higher values have recently been reported for Bramley's Seedling and Sturmer Pippin[3,4,5].

Tests on a limited number of apple varieties were made at Long Ashton in 1945, and the results have already been described[6]. Values higher than 10 mgm./100 gm. were only given by some of the culinary and cider varieties, the latter being richest in ascorbic acid with values up to 34 mgm./100 gm. for the whole fruit. During the 1946 season, more comprehensive tests have been carried out on freshly picked samples, and the values for the dessert and culinary varieties are shown in the accompanying table, expressed as mgm./100 gm. whole fruit. In addition, twenty-nine cider varieties have been tested and their contents of ascorbic acid found to lie within the wide range 7·5–39 mgm. These values are considerably higher than those generally assumed for English apples. Moreover, a number of seedling varieties raised at this Station gave values comparable with those in the table; for of sixteen varieties tested nine came within the range 15–27 mgm./100 gm.

Dessert varieties	Ascorbic acid (mgm./ 100 gm.)	Culinary varieties	Ascorbic acid (mgm./ 100 gm.)
Miller's Seedling	7·9	Golden Noble	6·9
Laxton's Superb	13·9	Edward VII	8·5
Cox's Orange Pippin	14·4	Early Victoria	10·8
Allington	15·0	Crawley Beauty	11·8
Ellison's Orange	15·5	Newton Wonder	14·6
Worcester Pearmain	16·0	Arthur Turner	15·3
Lord Lambourne	17·2	Lane's Prince Albert	15·4
Blenheim Orange	18·4	Bramley's Seedling	22·3
Rival	22·5		

As the highest concentration of ascorbic acid is in the skin of the fruit, the values found after peeling are always lower than those for the entire fruit; for example, the pulp of Bramley's Seedling was found to contain 15·5 mgm./100 gm. as against 22·2 mgm. for the unpeeled fruit. Taking into account such losses on peeling, it is still evident that the apple can be a fairly good source of ascorbic acid and one easily accessible. The actual level of the vitamin in a given variety will naturally depend on many factors still be to determined, while the effect of storage must also be considered: there is evidence, however, that storage losses need not be large[3,4].

Although the ascorbic acid is readily oxidized when the juice is pressed out of the fruit, the loss is not excessive in the ordinary methods of baking or stewing (with or without sugar). Tests on samples drawn from a batch of Bramley's Seedling showed that from a half to two thirds of the vitamin remained in the cooked fruit, a value similar to that found by Olliver[7]. No evidence was found for the production of appreciable amounts of interfering reducing substances during cooking.

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Nitrogen Fixation by Farmyard Manures

IN previous communications[1] it was reported that the value of farmyard manure (cow dung) is due not only to its nitrogen content but also to its power to fix nitrogen of the air. Our field experiments show that when wet, fresh collected cow dung is added to soil at the rate of 25 tons per acre, 33 lb. of nitrogen present in the cow dung is added and 135 lb. of nitrogen per acre is actually fixed from air, while in the dark the fixation is 65 lb. per acre.

These experimental results regarding the fixation of nitrogen by cow dung appear to be supported by the field trials at Rothamsted[2] and at Woburn[3]. In the Rothamsted field experiments, no combination of artificial fertilizers has been found to be so effective as farmyard manure in steadying crop-yields from year to year, and there was an increase of soil nitrogen to about three times its original value when farmyard manure was used for more than sixty years, while with ammonium sulphate or sodium nitrate the soil nitrogen remained practically stationary.

In the Woburn experiments, with farmyard manure added at the rate of 105 lb. of nitrogen per acre for thirty years and 82 lb. of nitrogen per acre for twenty years since 1876, the total nitrogen present in the soil in 1876 was 0·156 per cent and in 1927 in the barley plots it was 0·151 per cent, showing a small loss of only 0·005 per cent. In this period 4,790 lb. of nitrogen were actually added to the soil, and the crop grown on the soil absorbed approximately 2,450 lb. at the rate of 49 lb. of nitrogen per year. Hence the soil lost 2,450 lb. of the added nitrogen and about 124 lb. of the soil nitrogen, that is, 51·4 lb. of nitrogen per year. In the five years 1927–32, no farmyard or other manure was added to these plots, and three crops were withdrawn; the soil nitrogen fell from 0·151 to 0·123 per cent, showing a dead loss of 114 lb. of nitrogen per acre. It appears, therefore, that the less-marked loss of soil nitrogen in presence of farmyard manure is due to the fact that the loss is actually compensated by fixation of atmospheric nitrogen in the presence of farmyard manure.

Moreover, the Woburn experiments with the dung obtained by feeding decorticated cotton cake, containing 6·6 per cent nitrogen and maize-meal, with 1·7 per cent nitrogen, did not reveal any superiority of the cake-feeding over corn-feeding in the manuring of wheat and barley.

These observations have not yet been explained; but it appears to be clear that the dung of animals having maize-meal and containing smaller amounts of initial total nitrogen fixes atmospheric nitrogen; this makes up for its deficiency of total nitrogen due to the greater percentage of carbon in the maize-meal and its oxidation.

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Chromosome Numbers of British Species of the Genus *Rorippa* Scop. (part of the Genus *Nasturtium* R.Br.)

FOUR species of the genus *Rorippa* occur as members of the British flora, one of them (*R. austriaca*) being an alien[1]. Like many British plants, however, their chromosome numbers have only been determined from European material. These counts are given in Table 1.

TABLE 1

Species	Chromosome number *n*	Chromosome number 2*n*	Author
R. sylvestris (L.) Besser		32	Manton[2]
R. islandica (Oeder) Borbás	8		Jaretzky[3]
R. islandica (Oeder) Borbás	16		Scheerer[4]
R. amphibia (L.) Besser		32	Wulff[5]
R. austriaca (Crantz) Besser		16	Manton[2]

Thus the genus includes both diploid and tetraploid species, and one species, *R. islandica*, has both diploid and tetraploid forms.

In connexion with a survey of the possible relatives of diploid and tetraploid watercress (*Nasturtium officinale* and *N. uniseriatum*)[6], I have counted the chromosome numbers of British specimens of *Rorippa* species. These counts are given in Table 2.

TABLE 2

Species	Chromosome number *n*	Chromosome number 2*n*	Locality
R. sylvestris	24	48	Newry, etc.
R. islandica		32	Thames bank wall, Kew
R. amphibia		16	Thames bank wall, Kew
R. austriaca		16	Waste ground by Thames (Chiswick).
× *R. erythrocaulis* Borbás		24	Thames bank wall, Kew

The discrepancy between the two counts for *R. sylvestris* have been previously discussed[7]. The specimen of *R. islandica* of which the chromosome number was counted was of the type with fruits of normal length. It would be interesting to know whether the type of this species with short fruits (var. *microcarpa*)[8] is the form with a somatic chromosome number of $2n = 16$. My count for *R. amphibia* disagrees with the previous count, and it appears that this species also includes diploid and tetraploid forms, as does *R. islandica*.

The hybrid × *R. erythrocaulis* has been determined from its morphology[9] to be *R. amphibia* × *R. islandica*. Its somatic chromosome number of 24 confirms the suggestion that it comes from the cross *R. amphibia* ($n = 8$) × *R. islandica* ($n = 16$), and it is interesting to note that both the parents still occur in its vicinity. Pollen mother-cells of this hybrid showed 7–8 bivalents and 10–8 univalents.

My thanks are due to Mr. N. Y. Sandwith of Kew for collecting the specimens, and to Mr. V. Chapman for making the cytological preparations.

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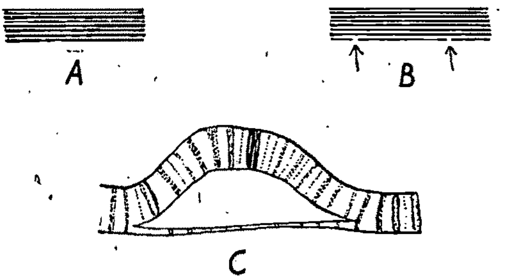
Production of Structural Changes in Somatic Chromosomes of *Drosophila melanogaster*

AUERBACH[1,2,3,4] reported that the exposure of adult males to the vapours of allyl isothiocyanate increases the mutation-rate in *Drosophila melanogaster*. About a fifth of the lethals thus produced were found by Slizynska and Slizynski[5] to be connected with cytologically detectable deficiencies, and in addition, there were about 7 per cent of gross structural changes. Auerbach[2] found also that the same chemical treatment of female embryos leads to high frequency of mosaicism, which is almost solely due to somatic crossing-over.

In this connexion an experiment has been carried out using a method described by Slizynska and Slizynski[6] for the production of somatic structural changes observable in salivary gland chromosomes. Freshly laid eggs were divided into three lots. The



Mechanism of origin of partial somatic structural changes in salivary gland chromosomes. *A*: salivary gland chromosome at a stage of 8 chromonemata. *B*: the agent produced breaks or other changes excluding the part between the arrows from the continuity of multiplying chromonemata. *C*: The fully developed salivary gland chromosome with a side connexion formed by the union of two ends. The diagram illustrates the origin of partial deficiency

first lot received no treatment, the second lot was treated with X-rays (400 r.) 5–12 hours after being laid. The third lot was exposed at the same time and age to the vapour of allyl isothiocyanate. I am indebted to Dr. J. M. Robson of the Department of Pharmacology, University of Edinburgh, for carrying out the chemical treatment.

The salivary gland chromosome of the fully grown larvæ was examined in order to detect somatic structural changes. From earlier work on the irradiation of young embryos, it was known that these changes when produced during early stages of the development of salivary gland chromosomes usually appear as narrow connexions between more or less distant parts of the same or different chromosome. They may be interpreted as deficiencies, inversions, etc., affecting only a part of the whole bundle of chromonemata constituting the salivary gland chromosome. The hypothetical mechanism of their origin is schematically represented in the accompanying drawings.

The results of cytological examination of forty-two slides, each with the salivary gland of a single larva (containing on the average 15–20 well-spread nuclei which were examined), are shown in the accompanying table.

FREQUENCY OF SOMATIC STRUCTURAL CHANGES INDUCED BY VARIOUS TREATMENTS

Treatment	Number of larvæ examined	Number of somatic structural changes found
Control	12	—
X-rays	9	55
Allyl isothiocyanate	21	79

The data clearly show that allyl isothiocyanate is very effective in producing somatic structural changes in chromosomes of salivary gland nuclei of *Drosophila melanogaster* when applied during their development, but since the dose given could not be compared with that of X-ray series, nothing can be said about the relative power of this agent in producing somatic structural changes.

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Labilization of the α-Hydrogen of Amino-acids in the Presence of Aminopherase

It has been shown previously in experiments with crude glutamic aminopherase, α-deuterio-alanine and α-ketoglutarate that enzymatic transamination involves dissociation of the α-hydrogen of the original amino-acid and its replacement, in the newly formed amino-acid, by a hydrogen ion derived from the aqueous medium[1]. In the non-enzymatic transamination reaction of Herbst, associated with decarboxylation of the NH_2-donating amino-acid, there occurs no dislocation of labelled α-hydrogen (Herbst and Rittenberg[2]). The reaction mechanisms have been discussed by Herbst[3] and Braunstein[4].

Our studies on the dissociation of α-hydrogen in the presence of aminopherase have been extended to other amino-acids, and the role of α-keto-acids and components of the enzyme system has been investigated. The methods of Schoenheimer and associates[5] were used in labelling *l*-glutamic acid, *dl*-alanine, *l*-leucine, *l*-aspartic acid and glycine with deuterium in the α-position. The enzyme was a highly purified preparation of glutamic-alanine aminopherase[6]. Transamination-rates were measured by colorimetric determination of pyruvate[6], and α-hydrogen dissociation by densimetric estimation of the amount of deuterium passing into the aqueous medium upon incubation[1]. Some of the experimental results are shown in Table 1. (In enzyme-free controls, variations of deuterium-content of the water did not exceed 0·0010 atom per cent; higher excess values are significant.)

Upon incubation of α-deuterio-*l*-glutamic acid with aminopherase, both in the presence of pyruvate or α-ketoglutarate, *and in the absence of α-keto-acids*, that is, when there is no transamination, the α-hydrogen undergoes dissociation, and most of it is recovered in the aqueous medium. In the case of α-deuterio-*dl*-alanine, *there is no dissociation without added keto-acid*. However, approximately half the α-hydrogen (that is, that of one stereoisomer) is labilized, and passes into the water in the presence of ketoglutarate or pyruvate. (In the latter instance the system contains no dicarboxylic reaction partner, known to be essential for transamination proper.) Equilibrium distribution of deuterium is reached even with low amounts of pyruvate (25 μM per 900 μM *dl*-alanine). Acetone fails to replace the α-keto-acids.

With aminopherase solutions inactivated by boiling (15 min.) identical results were obtained: in contrast to the thermolabile catalysis of NH_2-transfer, α-hydrogen labilization is a thermostable function of the enzyme.

In reaction mixtures containing α-keto-acids it has not been possible to detect inhibition of transamination by carbonyl reagents (Vyshepan[7]). With labelled glutamic acid in the absence of α-keto-acid, participation of a catalytically active carbonyl group of the enzyme in α-hydrogen labilization is demonstrated by the total suppression of the reaction by $M/500$ phenylhydrazine, and 50 per cent inhibition by $M/500$ hydroxylamine. The prosthetic group of transaminating enzymes has recently been identified with phosphopyridoxal[8,9,10,11]. In absence of the protein moiety of the enzyme, synthetic phosphopyridoxal[12], added to deuterioglutamic acid (with or without pyruvate), failed to induce α-hydrogen labilization in our experiments (Table 2).

TABLE 1. DISSOCIATION OF α-HYDROGEN FROM α-DEUTERIO-*l*-GLUTAMIC ACID (1·0 ATOM PER CENT D) AND α-DEUTERIO-*dl*-ALANINE (1·28 ATOM PER CENT D) IN THE PRESENCE OF GLUTAMIC-ALANINE AMINOPHERASE (25 LENARD – STRAUB UNITS[6]). SAMPLES (TOTAL VOLUME, 6 ML.) INCUBATED 2 HR. AT 38° C.

Composition of samples	With active enzyme		With boiled enzyme		Without enzyme	
	Excess D in water atom per cent	Trans-amination μmol.	Excess D in water atom per cent	Trans-amination μmol.	Excess D in water atom per cent	Trans-amination μmol.
300 μ*M* Glutamate	0·0036	0	0·0034	0	0·0003	0
,, ,, ,, + 300 μ*M* pyruvate	0·0053	140	0·0037	0	0·0000	0
500 μ*M* ,, + 500 μ*M* ketoglut.	0·0070	not detectable	0·0070	–	0·0000	–
900 μ*M* Alanine	0·0000	0	0·0002	0	0·0000	0
,, ,, ,, + 450 μ*M* ketoglut.	0·0054	90	–	0	–	–
,, ,, ,, + 450 μ*M* pyruvate	0·0079	not detectable	0·0055	–	0·0010	–
900 μ*M* Alanine						
,, ,, ,, + 450 μ*M* pyruvate	0·0091	–	–	–	–	–
,, ,, ,, + 25 μ*M* pyruvate	0·0073	–	–	–	–	–
,, ,, ,, + 300 μ*M* acetone	0·011	0	–	–	0·0011	0

TABLE 2

Composition of samples	Excess of D (atom per cent) in water	
	With enzyme	Without enzyme
300 μ*M* Glutamate	0·0036	0·0000
,, ,, ,, + 50 μgm. phosphopyridoxal	—	0·0009
,, ,, ,, + 50 μgm. phosphopyridoxal + 300 μ*M* pyruvate	—	0·0006
,, ,, ,, + *M*/500 hydroxylamine	0·0018	0·0003
,, ,, ,, + *M*/500 phenylhydrazine	0·0006	0·0007

Preliminary experiments have been made with active or boiled glutamic-alanine aminopherase and labelled di- or mono-carboxylic amino-acids *not available for transamination* with this enzyme (aspartic acid, leucine) or with any known transaminating system (glycine). It appears that the α-hydrogen of these substrates is dissociated as readily as in alanine when α-keto-acids are present, while there is no labilization in their absence. It seems also that α-keto-isocaproic acid and glyoxylic acid, though inadequate as NH_2-acceptors in transamination, are able to induce enzymatic labilization of the α-hydrogen of monocarboxylic amino-acids.

Dislocation of α-hydrogen in glutamic acid can be interpreted as due to reversible condensation of the amino-group with the carbonyl in the prosthetic component of aminopherase to form a prototropic system (Schiff's base)[3,4], but it is not clear at present why alanine and the other amino-acids tested, except glutamic, fail to react unless a keto-acid is present.

It appears from the reported data that (*a*) labilization and dissociation of α-hydrogen, and (*b*) transfer of NH_2-groups (and electrons) are two distinct and successive enzyme-catalysed stages of transamination. Reaction *a* is an independent, relatively non-specific and heat-resistant function of aminopherase, prerequisite for, but not necessarily followed by, reaction *b*.

On the assumption that there exists no enzyme-catalysed exchange of 'stably bound' hydrogen, replacement of the α-hydrogen of amino-acids in isotope experiments with living organisms has been interpreted in several instances as evidence for reversible deamination, especially for dehydrogenation at the α-carbon of the amino-acids[13,14,15,16]. Our data cast a doubt on the validity of this interpretation and suggest a different mechanism for the intravital replacement of α-hydrogen in amino-acids.

A full account of this work, and discussion of its broader implications with regard to enzymatic hydrogen translocations in general, will be published elsewhere.

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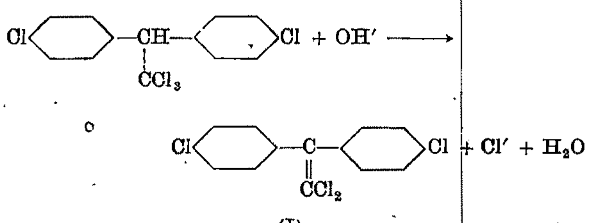
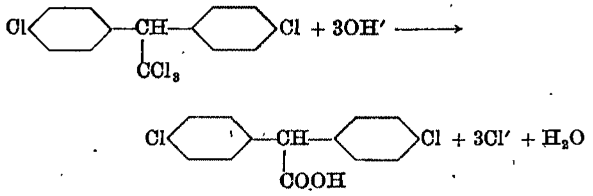
Dehydrohalogenation of *p*,*p*′-D.D.T.

THE dehydrohalogenation of 2,2-*bis* (*p*-chlorophenyl)-1,1,1-trichloroethane (*p*,*p*′-D.D.T.) to form 2,2-*bis* (*p*-chlorophenyl)-1,1-dichloroethylene (D.D.X.), readily brought about by refluxing with alcoholic alkali[1], has been utilized[2-7] for its estimation.



(I)

Such methods are usually based on the determination of chloride ion present in the products of this reaction; and it has hitherto been accepted that under the conditions used, dehydrohalogenation proceeds quantitatively as in the above equation. Our results indicate that this is not so. Thus, when p,p'-D.D.T. is refluxed for 30 minutes with N alcoholic potassium hydroxide (compare Gunther[2]), some 1·04 chloride ions per molecule of p,p'-D.D.T. are liberated, and in addition to D.D.X., *bis* (p-chlorophenyl) acetic acid can be isolated from the reaction mixture. Although this acid can be readily prepared from both p,p'-D.D.T. and D.D.X. by more drastic treatment with alcoholic alkali[8,9,10], D.D.X. is almost completely stable to the action for 30 minutes of boiling N alcoholic potassium hydroxide. This suggests that D.D.X. is not normally an intermediate product in the formation of the acid from p,p'-D.D.T., but that this arises from a direct hydrolysis of the —CCl_3 group to —COOH, a reaction in which three chloride ions are liberated.



(II)

Similar results have been obtained by Cristol and Haller[11] with 2-o-chlorophenyl-2-p-chlorophenyl-1,1,1-trichloroethane (o,p'-D.D.T.). These workers also showed[11] that o,p'-D.D.T. treated with alcoholic sodium hydroxide at room temperature loses approximately one molecule of hydrogen chloride per molecule, although some formation of the corresponding acid occurs when the reaction is performed under reflux.

Our results indicate that although treatment of p,p'-D.D.T. with $0·1\,N$ or N alcoholic potassium hydroxide at room temperature can lead to the formation of *bis*(p-chlorophenyl) acetic acid, the amount is too small materially to affect the analytical result. It is, therefore, suggested that such conditions approximate more nearly to those required for the quantitative estimation in accordance with equation I.

Details of this work will be published elsewhere.

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A Marine Bed in the Coal Measures of Northumberland

The absence of true marine horizons—apart from occurrences of *Lingula*—in the Northumberland–Durham Coalfield has long been a matter of surprise to geologists generally. In 1939, however, Mr. Tonks described some small goniatites in calc-ironstone bullion (found in a cabinet of rock-specimens in the Hancock Museum, Newcastle) which had been collected during the sinking, 1858–59, of the Ryhope Shaft, Co. Durham, and, in his paper[1], expressed the hope "that some future pit sinking will yield the rich fauna of the Mansfield–Skipsey band". This discovery by Mr. Tonks indicated the probable existence of such a band, approximately 500 ft. above the High Main Coal seam, which is the boundary on Geological Survey maps between the Upper and Middle Groups of the Coal Measures.

Much of the Northumberland–Durham Coalfield is comparatively shallow, and it is only in isolated parts, due to faulting, or along the east side of Durham—mainly beneath the Permian—that sufficient cover of strata is obtained to include beds 500–1,000 ft. above the High Main. Such areas, for economic reasons, are seldom penetrated by bores or sinkings from the surface; moreover, in the unconcealed part of the coalfield, these outcrops are completely masked by boulder clay. Nowhere in Northumberland has an opportunity occurred for a great many years back to examine these very high Coal Measures strata. This year, however, the Ashington Coal Co. Ltd., started a boring programme, and one bore east of Ashington near the southern boundary of 1-in. Geological Survey Sheet 10 commences in strata approximately 600 ft. above the High Main.

Among the highest strata cored in the above bore is a dark-grey, poorly bedded shale, 1 ft. 5 in. thick, with marine fossils. The shale is at 90 ft. 5 in. below the surface and, as near as can be determined from underground levels, 492 ft. above the High Main. In the bore this shale overlies a 2-in. bituminous coal and is surmounted by a 5-in. ironstone band, also containing traces of shells. The fossils found in the shale are reported as follows:

Productus (*Dictyoclostus*) *craigmarkensis* Muir-Wood.
Productus (*Dictyoclostus*) cf. *retiformis* Muir-Wood.
Productus (*Productus*) *carbonarius* de Koninck.
Lingula sp. (fragments).
Anthracoceras cf. *hindi* Bisat.
Goniatite, gen. et sp. nov. (as described and figured by C. Duncan from Skipsey's Marine Bed[2]).
Metacoceras aff. *cornutum* Girty.
Orthocone nautiloid (probably *Pseudorthoceras* sp.).
Posidonia sulcata (Hind)
? *Parallelodon* sp.
Hindeodella sp.
Streptognathodus sp.
Pleurophorella ?
Small pyritized gastropods and fish debris.

Dr. C. J. Stubblefield and Mr. F. W. Anderson, who determined these, are of the opinion that the 'Ashington Marine Bed' is the Skipsey Marine Bed of Scotland and the Bolton marine horizon of Cumberland. Until the boring programme is completed, however, it is not desirable to go into greater correlative detail.

This preliminary announcement is made with the permission of the Director of H.M. Geological Survey.

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DILATANCY AND THIXOTROPY

A DISCUSSION on the subjects of dilatancy and thixotropy, arranged jointly by the Faraday Society and the British Rheologists' Club, was held on December 10 at the rooms of the Royal Society of Arts. Sir Charles Goodeve, in opening the discussion from the chair, said that the gap between the colloidal chemist and the physicist is being bridged by the rheologist. Mr. R. L. Brown, of the British Coal Utilisation Research Association, gave a survey of researches on the phenomenon of dilatancy; this was followed by a survey of thixotropy by Dr. E. W. J. Mardles.

We owe the term 'dilatancy' to Osborne Reynolds (1885), who established the classical conditions for the onset of turbulence in fluids. The ideas of Reynolds number and of dilatancy apparently arose in an attempt to formulate a mechanical theory of the ether. Reynolds originally observed that a tightly packed mass of sand enclosed in a flexible envelope and subjected to a deformation expanded or dilated (the footprint-on-wet-sand effect). This dilatation is a well-known geometrical necessity for spheres in close packing, the spheres having centrally directed forces between them; but where frictional forces are involved, the expansion takes place along a line of slip and not by a general motion of each particle to a more expanded position. Furthermore, even if the initial arrangement is disordered or if the particles are irregular, lines of slip appear with shear, a co-operative movement of particles occurring whereby whole groups of particles slide where the packing is loose.

Sir Lawrence Bragg[1] has shown in beautiful experiments with soap bubbles in contiguity that the system contains ordered regions which do not mesh perfectly with one another and show an intercrystalline boundary. During dilatation, particles in contact may become separated by gaps; and as forces cannot be transmitted across these gaps, the particle pattern determines the stability of the packing. The pattern of the gaps is the obverse of arching and bridging. Golder[2] sheared, at constant rate of strain, sands and clays contained in a box split along a horizontal plane; and he found that a dense sand dilated, the shear stress rising to a maximum and falling to a constant when dilatation is complete. A loose sand contracted, and the stress rose to a constant value; while brittle clay expanded slightly on shear, and a plastic clay behaved similarly to loose sand.

Freundlich and co-workers, Williamson and Heckert, and others have found with pastes, muds and other concentrated suspensions that dilatancy (indicated by increase in apparent viscosity, consistency or strength with increase in rate of shear) is dependent narrowly on concentration of the solid, being 40–45 per cent for starch or silica. Sheets[3], working with clay slips, found a critical concentration of 60–70 per cent corresponding to close packing, so dilatancy here is in the Reynolds sense, or may be due to the packing characteristic of anisometric particles.

Williamson and Freundlich attribute dilatancy in pastes and suspensions to a 'snowplough' effect: at about 40 per cent concentration, mutual interference of particles occurs and the pattern of flow becomes important. Presumably, the particles become stratified, with clear medium between.

The word 'thixotropy', meaning change by touch, designating the reversible loss of apparent viscosity, consistency or strength of a system, accompanying the application of a shear or the increase in the amount of the applied shear, was first used by Freundlich and Peterfi in 1927 to describe the behaviour of some colloidal systems and suspensions of gypsum, slate powder, etc., which they found to liquefy when shaken or touched and to regain their original solid state after resting. The phenomenon must have been long familiar to those working with plastic masses, sludges and precipitates: v. Kuhne (1863) recorded that a nematode wandering through a muscle cell caused liquefaction with subsequent resetting after rest, and Beilby (1921) in a long series of elegant experiments showed that the surface layers of metals, crystals, etc., could be temporarily liquefied by gentle rubbing. He mentions that barium platinocyanide crystals change from a yellow solid to a brown liquid by pressing them lightly. The range of thixotropic materials extends from the hardest solids, through doughs and pastes to liquids such as blood or milk, which liquids show a reversible decrease in viscosity on movement. Familiar materials, such as furniture cream, cod liver oil emulsion, mayonnaise, greases, clays and muds, quicksands, heather honey, dairy produce, etc., have afforded workers with material for thixotropic study.

Thixotropy is usually a desirable property. It allows of the sharpening of a steel razor by gentle stropping, when liquefaction of the surface layer occurs; although a soap-thickened oil remains rigid in the grease cup, when submitted to shearing stresses in a bearing it liquefies, and its apparent viscosity approaches that of the oil medium itself. Printing inks under the pressure of rollers liquefy and wet the paper, while the spread film solidifies when pressure is released. Thixotropy is of significance in biology: when a sea-urchin egg undergoes division, the fluid protoplasm becomes converted into two jelly-like, semi-solid masses which can be liquefied by jerking with a micro-needle. After removal of the needle, the original jellied condition slowly returns and the division of the egg proceeds normally.

The query whether systems with immediate re-solidification after shear liquefaction should be regarded as thixotropic in the same sense as those which require an appreciable time of several minutes or hours for recovery has been raised; but it has been found convenient to consider them as thixotropic as Freundlich did with a 10 per cent silica/carbon tetrachloride suspension, which is liquid on shaking but shows no signs of flowing when the containing tube is inverted immediately after shaking. When a liquid possesses an apparent viscosity which decreases with an increase in the rate of shear, this thixotropy, because of its being associated with stress increase, has been termed 'stress thixotropy', while that associated with strain increase has been termed 'strain thixotropy'. When after shearing there is a loss of consistency but with no return to the original state, this non-reversible behaviour can be termed 'shear breakdown' or 'rheodestruction'. A system showing a decrease in consistency without reaching the fluid state completely has been regarded as possessing false body by Pryce Jones, but such systems are regarded as thixotropic in the sense that a complete transformation from solid to liquid is not a prerequisite for thixotropy; a partial transformation is all that is necessary.

A material can behave both as a rigid solid with measurable rigidity and as a liquid, according to the amount of stress applied; with increase in shearing stress, the threshold at which the material begins to pass from a rigid solid to liquid is called the 'yield value' or 'yield stress'. As Beilby pointed out, the rigidity of a system is a consequence of the molecular aggregation, and Goodeve[4] has considered the yield value in terms of structure to be given by the strength and number of links per unit volume. D/τ diagrams, relating τ, the shearing stress, and D, the rate of shear, form the basis for classification of rheological systems; and this relation of Newton to which rheology owes much of its advance is a convenient form of analysis. The thixotropic time of recovery on D/τ diagrams has been shown by a hysteresis loop when a rising and falling rate of shear has been used.

Thixotropy is especially associated with asymmetric particles. Needles, rods or plates in suspension tend to become orientated in the flow stream, with a consequential lowering of viscosity. Asymmetric particles can form by flocculation a three-dimensional structure at very low concentrations which is easily damaged by shear. Non-spherical particles favour thixotropy, since they will not satisfy the condition of closest packing so necessary for dilatancy.

Thixotropy found with systems of spheres or grains such as precipitated silica appears to be due in the main to flocculation: when flocculation bonds are broken by movement, they tend to heal on resting. The phenomenon of flocculation is not clearly understood, but is closely related to the dispersive power of the medium, which in turn is related to the interfacial activity.

Dr. A. S. C. Lawrence spoke on the temperature coefficient of thixotropy in relation to the rate of flocculation influenced by Brownian movement and viscosity, and mentioned that thixotropy in emulsions with deformable droplets is due to particle asymmetry reaching an axial ratio as high as ten to one.

Mr. J. Pryce Jones gave instances of suspensions altering completely their flow behaviour on the addition of small quantities of colloids and materials which affect wetting; or when the concentration or the rate of shear was increased. The rheology of suspensions is fundamentally dependent on the dispersion coefficient of the medium. Prof. D. H. Bangham, dealing with two properties of solid/liquid interfaces, namely, the heat of wetting and equilibrium contact angle, which appear to have an important bearing on the properties of suspensions, pointed out differences between these two criteria of wettability. Film configurations and 'ghost' interface properties of fine particles become significant or even dominant in dense suspensions where the number of molecules in close proximity to the solid surface is relatively great. Dr. Scott Blair spoke on the sigma phenomenon; a satisfactory explanation was obtained by using a summation equation, allowing for the size of particles relative to the radius of the tube, instead of the integration for a continuum.

Mr. A. de Wael discussed the kinetics of thixotropy, the appearance of yield values in cellulose/ether systems by the change in solvent and the dilatancy of lecithin/glycerol systems with large irregularly dispersed particles. After some discussion on definitions, there was agreement that the time-dependent solid–liquid–solid form of thixotropy, as noted by Freundlich and Peterfi in colloidal systems, forms part of a larger phenomenon when time of recovery to the original state may be immediate. Sir Charles Goodeve, in conclusion, summarized the several important factors responsible for anomalous flow behaviour. He emphasized the need for using carefully designed instruments, pointing out that many 'anomalies' were due to faulty instrumentation. A rational approach to flow problems, he said, is the kinetic one of the time-dependence of linkage-breaking per unit volume; the elastic behaviour of some liquid systems still needs exploration.

E. W. J. MARDLES

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CHEMICAL ENGINEERING AT THE UNIVERSITY OF LEEDS

FOLLOWING the institution of degree courses in chemical engineering by the University of Leeds in 1942, the Department of Coal Gas and Fuel Industries has been acquiring additional items of chemical plant to equip a special laboratory for the study of unit operations. Despite the difficulties imposed by the War and post-war periods, equipment covering most of the principal chemical engineering operations has now been obtained.

The units are sufficiently large to ensure a performance and technique of operation similar to that of commercial plant, and in addition are provided with a full range of measuring instruments. Installations include a double-effect evaporator, still and fractionating column, rocking crystallizer, centrifuge, filter press and rotary vacuum filter, jacketed pan, heat interchanger, tray drier, double-drum film drier, kneading type mixer and a super-centrifuge. Extreme congestion has necessitated housing some of the equipment in outbuildings, but most of it is accommodated in an annexe to the main building which has been named the Charles Brotherton Chemical Engineering Laboratory. The present location is temporary, and when conditions permit, the whole of the equipment will be transferred to an adequate and permanent building.

On December 12, the second Brotherton Lecture of the Society of Chemical Industry was delivered in Leeds by Dr. D. T. A. Townend, and the opportunity was taken of arranging for the temporary Chemical Engineering Laboratory to be formally opened prior to the Brotherton Lecture.

Members of the gas, coking and chemical industries were present. More than a hundred visitors assembled in the Chemistry Lecture Theatre of the University to hear the Vice-Chancellor (Mr. B. Mouat Jones) pay tribute to the many friends represented at the gathering, whose generosity had made possible the implementation of the schemes for chemical engineering training. Once again, he said, the University is indebted to Mr. Charles Brotherton and Messrs. Brotherton and Co., who had provided £55,000 towards the cost of a new building when this became possible, as well as gifts for chemical engineering equipment and endowments to provide staff. The Department had also received most generous and continued support for general equipment from the gas industry, through the Joint Standing Finance Committee of the Institution of Gas Engineers, the

National Gas Council and the British Commercial Gas Association. He also expressed thanks to the many industrial firms for financial support, or for equipment provided either free of charge or under most favourable terms.

Dr. D. T. A. Townend (director, British Coal Utilisation Research Association, and formerly Livesey professor in the University) then gave a brief history of the Department. He paid tribute to the foresight of the late Prof. W. A. Bone, who established courses of training on such a broad basis that they were, in effect, largely chemical engineering. Any doubts there might have been about the need for chemical engineers are now completely resolved by the great and growing demand for such men and, consequently, for their training. For completion, the Leeds courses had needed more facilities for the study of unit operations; now that these were available, although the plant was most inadequately housed, the University could offer with confidence a full and balanced course in the subject.

Visitors then proceeded to the Department of Coal Gas and Fuel Industries, where the brief formal ceremony of opening the Laboratory was performed by Mr. George Brotherton-Ratcliffe, in the unavoidable absence of Mr. Charles F. R. Brotherton. A brief tour of inspection of the Chemical Engineering Laboratory and the Department as a whole was then made.

JAPANESE EARTHQUAKE OF DECEMBER 21, 1946

At about 04.20 hr. on December 21, 1946, an earthquake of considerable severity originated in the Pacific Ocean some 100 miles off the coast of Wakayama, Japan. The shock was recorded on seismographs throughout the world and was felt, causing some apprehension, in Tokyo. Buildings were shaken, causing damage throughout the island of Shikoku, and on much of the surrounding mainland, including the towns of Hiroshima, Kure, Kobe, Osaka, Kyoto, and Wakayama. The area severely shaken was more than 400 miles long and 150 miles wide, and railway lines were blocked throughout Shikoku. Several villages, including Singu, were severely damaged by fire caused when household fires were scattered about the wooden buildings.

The earthquake was probably accompanied by a sudden alteration of the floor of the ocean in the neighbourhood of the epicentre, because a seismic sea wave or *tunami* resulted, and this caused much damage around the coast. At Koshi, a coastal town with a population of 100,000, and at nearby Takoaka, the wave was a few feet high, and in some places advanced up to five miles inland before retreating. As the wave advanced up the Kii-awadi Straits between the island of Shikoku and the mainland, it became higher until at Osaka, a coastal town with a population of 3,000,000, it attained a height of nearly 10 feet. Kushimoto, a fishing village at the southern tip of Wakayama, was inundated, and the people of Kainan, who climbed on to their roofs and balconies after the first shock, watched the *tunami* roll in a few minutes later, wrecking many houses with a thunderous roar.

Altogether, the official Japanese radio report states that 1,026 people lost their lives, many more were injured and thousands of others rendered homeless. More than 1,400 fishing vessels were wrecked.

This is not the first time that a *tunami* has affected Osaka, lying as it does at the head of an elliptically shaped bay. One followed the great Nankaido earthquake of August 3, 1361, another on October 28, 1707, and yet a third after the Nankaido earthquake of December 24, 1854. These *tunamis* have a speed in some cases of as much as 30 ft. per second, and damage is thus caused by both their height and their speed. Prof. A. Imamura and others have suggested ways of mitigating disasters caused by these seismic sea waves.

The present shock had some of the characteristics of the Kwanto earthquake of September 1, 1923, but was nothing like so severe. On that occasion the first epicentre was in Sagami Bay, causing a vertical displacement of the sea bed of more than 300 ft. and a *tunami* 36 ft. high at the head of the Bay. Tokyo and Yokohama were largely destroyed, and the scattering of the household fires practically burned out what was left of the lower section of Tokyo and nearly all Yokohama. Nearly 100,000 people were killed. The railway bridge spanning the River Banyu-Gawa received a horizontal shaking of intensity equal to half its weight and collapsed, and the whole of the Kwanto earth block tilted a few metres, the south-east rising and the north-west sinking. As a result of the Kwanto earthquake unshipping the earthquake recorders, the Seismological Institute of Tokyo Imperial University later installed a seismograph with a minification of a half. Now, unless an earthquake has a range of motion greater than 13 in., this instrument will record it.

E. TILLOTSON

TIMBER DECAY AND ITS CONTROL

Leaflet No. 39 entitled "Timber Decay and its Control" (Pp. 12), issued by the Forest Products Research Laboratory, Princes Risborough, commences by discussing the methods of growth and general appearance of fungi and the large number of spores usually produced. Since it only requires one or two spores to infect a piece of wood, means must be found to prevent spores germinating and infecting wood. Conditions of growth are then considered and the nature of the decay.

Fungal decay of wood is in reality a chemical decomposition which is brought about by the ferments and acids secreted by fungi. The wood is, as it were, digested by the fungus, and part of it is transformed into liquids which are absorbed by the fungi as nutriment. Wood in an advanced stage of decay represents the residue which is of no use to the fungus, or which has not yet been utilized. Two main types of decay in wood may be distinguished.

1. *Brown Rots*. In these, the wood eventually becomes a dark brown, and in the final stages tends to break up into brick-shaped pieces as a result of cracking along and across the grain. Wood severely attacked by a brown rot can be readily crumbled under the fingers. The most important decays of softwoods are 'brown rots'. Chemically speaking, brown rots are distinguished by the fact that only the cellulose and the associated carbohydrates are attacked, whereas the lignin is left practically unchanged.

2. *White Rots*. Darkening of the wood is sometimes the first indication of the white rot, but eventually it becomes very much lighter in colour than normal.

This lightening in colour may be general or it may occur in patches, causing a white 'pocket' rot. Even in an advanced stage, wood attacked by a white rot does not crumble into powder under pressure, although it may disintegrate into a lint-like material. Most of the decay in felled hardwoods is caused by various types of white rot. The chemical action of a white rot is more complicated than that of a brown rot, since all the constituents of the wood are attacked, the lignin as well as the cellulose being broken down.

Rot in wood is often spoken of popularly as of two types—'wet rot' and 'dry rot'. This is a rather unsatisfactory division, since the two types are both caused by fungi which can only attack the wood when it is definitely damp. Dry rot has, however, come to acquire a rather specialized meaning, as the rot of timber in buildings that is brought about by one or two species of fungi such as *Merulius lacrymans*. This type of rot eventually leaves the wood in a dry, friable condition, but the fungus requires damp, ill-ventilated places in which to flourish, and it cannot attack really dry wood.

The diagnosis, effect and prevention of decay are discussed fully. The leaflet is well illustrated.

FORTHCOMING EVENTS

Saturday, January 11

Botanical Society and Exchange Club of the British Isles (at the Randolph Hotel, Oxford), at 3.30 p.m.—Dr. P. W. Richards: "The Biological Flora".

Tuesday, January 14

Institution of British Agricultural Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. A. P. Bevan: "The Mechanical Requirements of the Small Grower and Horticulturist".

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. W. D. Wright: "Colour in Illuminating Engineering".

Society of Chemical Industry, Food Group (joint meeting with the Liverpool Section of the Society, at the University, Liverpool), at 6.30 p.m.—Mr. P. N. Williams: "Synthetic Fats".

Society of Chemical Industry, Plastics Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. P. Staudinger: "Vinylidene Chloride and its Polymers".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Mr. J. D. Tallantire: "Continuous Process Measurement in Dirty Fluids".

Wednesday, January 15

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Douglas Wallace Bishopp: "The Scope and Future of Geology in Ireland".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Sir Charles Lidbury: "Economic Reconstruction, 1, Great Britain in relation to the World's Trade Situation".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. B. Bleaney, Mr. J. W. Ryde and Mr. T. H. Kinman: "Crystal Valves".

Sheffield Metallurgical Association (joint meeting with the Yorkshire Section of the Institute of Fuel, in the Lecture Hall, Central Library, Surrey Street, Sheffield), at 6.15 p.m.—Dr. J. H. Chesters and Mr. M. W. Thring: "Factors in Open Hearth Design".

Royal Institute of Chemistry, London and South-Eastern Counties Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. A. C. Monkhouse: "Recent Advances in Atmospheric Pollution Research".

Society of Chemical Industry, Newcastle-upon-Tyne Section (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. J. M. Pirie: "Silver and Platinum in Chemical Plant Construction".

Textile Institute, Lancashire Section (at 16 St. Mary's Parsonage, Manchester 3), at 7 p.m.—Mr. J. A. McWilliam: "Corrosion Resisting Steels for the Textile Industry".

Textile Institute, Macclesfield, Leek and District Section (at Nicholson Institute, Leek), at 8 p.m.—Dr. F. C. Toy: "Some Impressions of my American Tour".

Thursday, January 16

Royal Society of Arts, India and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. A. E. Foot: "The Doon School".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. H. L. Talbot: "The Development of Metallurgical Practice for the Treatment of Nchanga Mixed Oxide-Sulphide Ores".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. M. Whittaker: "Series of Polynomials".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. H. A. Thomas: "Industrial Applications of Electronic Techniques".

Society of Chemical Industry, Road and Building Materials Group (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6 p.m.—Short Papers on "Recent Developments in Testing Methods for Road and Building Materials".

Royal Photographic Society (joint meeting of the Scientific and Technical Group and the Colour Group, at 16 Princes' Gate, London, S.W.7), at 7 p.m.—Mr. A. Marriage and Mr. D. C. Gresham: "Masking and its Method" ("How it Works in Colour Photography", 3).

Textile Institute, Yorkshire Section (at the Midland Hotel, Bradford), at 7 p.m.—Mr. A. W. Robertson: "Glass Fibres, Yarns and Cloths".

Textile Institute, Belfast Branch (at the College of Technology, Belfast), at 7.30 p.m.—"Plastics Appertaining to the Textile Industry".

Thursday, January 16—Friday, January 17

British Social Hygiene Council (joint meeting with the Town and Country Planning Association, at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Conference on "The Family at Work and Play" (to be opened by Mr. Gilbert McAllister).

Friday, January 17

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. H. Knowler: "Recent Developments in Flying Boats" (Nineteenth Thomas Lowe Gray Lecture).

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. D. Jones: "Flame Spraying of Metals and Plastics".

Institute of Physics, Industrial Radiology Group (at the E.L.M.A., 2 Savoy Hill, Strand, London, W.C.2), at 6.30 p.m.—Mr. R. Meakin: "Sonic Methods in Non-Destructive Testing".

Society of Chemical Industry, Birmingham Section (at the Chamber of Commerce, Birmingham), at 6.30 p.m.—Mr. J. E. B. Randles: "Applications of the Cathode Ray Oscillograph to Polarography".

Institute of the Plastics Industry, North-Western Section (joint meeting with the Manchester Section of the Institution of the Rubber Industry, at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"German Plastics Industry". Dr. T. Love: "Thermosetting"; Mr. J. H. Rooney: "Thermoplastics".

Institute of Economic Engineering (at Cowdray Hall, Henrietta Place, London, W.1), at 7 p.m.—Annual General Meeting.

Paper Makers' Association (Technical Section), Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. C. Brown and Dr. H. Ainsworth Harrison: "Organic Mercurials for Slime Prevention".

Chemical Society, Cambridge Section (in the University Chemical Laboratory, Cambridge), at 8.30 p.m.—Prof. M. Stacey: "Macromolecules Synthesised by Micro-organisms" (Tilden Lecture).

Institution of Structural Engineers, Lancashire and Cheshire Branch (at the College of Technology, Manchester).—Mr. Leonard C. Howitt: "Architecture Related to Structural Engineering".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Assistant with qualifications and experience in Chemical Engineering, at the Bradford Technical College—The Director of Education, Town Hall, Bradford (January 18).

Assistant for miscellaneous duties connected with a scientific information service and an abstracting journal—The Director, Imperial Bureau of Dairy Science, Shinfield, Reading (January 18).

Lecturer in Electrical Engineering in the Ashington County College and Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (January 18).

Research Specialists (2) in Applied Physiology at the Royal Air Force Institute of Aviation Medicine, Farnborough, Hants.—The Under-Secretary of State, Air Ministry (S.2q), Cornwall House, Waterloo Bridge Road, London, S.E.1 (January 20).

Lecturer in Physical, Organic, Inorganic and Industrial Chemistry, a Lecturer in Diploma Mathematics (Post Matric. standard), a Lecturer in Diploma Physics (Post Matric. standard), a Lecturer in Electrical Engineering, a Lecturer in Mechanical Engineering, and a Lecturer in Civil Engineering, in the Technical Education Branch of the Department of Public Instruction, New South Wales—The Official Secretary, New South Wales Government Offices, 125 Strand, London, W.C.2 (January 25).

Lecturers (2) in the Department of Chemistry, Leeds College of Technology—The Director of Education, Education Office, Leeds 1 (January 25).

Lecturer in Chemical Engineering, and a Lecturer in Physical Chemistry, at the West Ham Municipal College—The Education Officer, Education Department, 95 The Grove, Stratford, London, E.15 (January 27).

Medical Research Bacteriologist—The Clerk of the Board, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, endorsed 'Medical Research Bacteriologist' (January 31).

Assistant Lecturer in Electrical Engineering—The Registrar, College of Technology, Manchester 1 (January 31).

Lecturer in Geology—The Registrar, King's College, Newcastle-upon-Tyne (January 31).

Lecturers (Grade III and Grade II) in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Liverpool (January 31).

Assistant Lecturer (Grade III) in the Department of Physics—The Secretary, The University, Edmund Street, Birmingham 3 (January 31).

Lecturer in Physiology—The Secretary, The University, Edmund Street, Birmingham 3 (January 31).

Medical Artist—The Dean, British Postgraduate Medical School, Ducane Road, London, W.12 (January 31).

Assistant Government Chemists, Nigeria—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (February 1).

Assistant Lecturer (Grade III) in Oceanography (Applied Mathematician)—The Registrar, The University, Liverpool (February 8).

Senior Lecturer in Electrical Engineering at Canterbury University College, Christchurch—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (February 14).

Lecturer in Chemistry (to deliver lectures in Physical or Inorganic Chemistry), at Auckland University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (February 15).

Assistant Physicist—The Secretary, Sheffield National Centre for Radiotherapy, Broom Cross, Tree Root Walk, Sheffield 10 (February 17).

Chair of Design in the School of Architecture, Auckland University College—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (February 28).

Posts as Director in the Imperial Agricultural Bureaux of Animal Breeding and Genetics, and of Forestry—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (March 1).

Wilde Readership in Mental Philosophy—The Registrar, University Registry, Oxford (March 8).

University Graduates and qualified teachers for short service commissions in the Education Branch of the Royal Navy—The Director, Education Department, Admiralty, London, S.W.1.

Entomologist, Bermuda—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1.

Lecturer in Chemistry, and a Lecturer in Electrical Engineering, at the Cardiff Technical College—The Director of Education, City Hall, Cardiff.

Technical Assistant—The General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester 3.

Parasitologist, and an Organic Chemist—The Director, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Canada.

Research Chemist—The Director of Research, Cereals Research Station, Old London Road, St. Albans.

Biochemist (university graduate with experience in clinical biochemistry and familiar with optical method of analysis) in the Ministry of Health Area Laboratory—The Medical Superintendent, City Hospital, Hucknall Road, Nottingham.

Lecturer in Chemistry—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Technician (skilled) as a Physics Research Assistant, and Trainee Technicians for the Departments of Physiology and Pathology—The Secretary, Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

Research Assistant in the Mechanical Testing Section—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1945. Pp. 230. (Bristol: Agricultural and Horticultural Research Station, Long Ashton, 1946.) [278

Imperial Agricultural Bureaux. Joint Publication No. 11: Some British Books on Agriculture, Nutrition, Forestry and Related Sciences, 1939–1945. List compiled by H. M. Bedington. Pp. v + 37. (Aberystwyth: Imperial Agricultural Bureau, 1946.) 3*s*. [278

Imperial Bureau of Plant Breeding and Genetics. The Use of Heterosis in the Production of Agricultural and Horticultural Crops. By T. Ashton. Pp. iii + 30. (Cambridge: Imperial Bureau of Plant Breeding and Genetics, 1946.) 3*s*. [278

What is UNESCO? Pp. 12. (London: United Nations Educational, Scientific and Cultural Organisation, 1946.) [278

British Colliery Owners Research Association. Report on the Work of the Mining Research Laboratory during the Two Years ended March 1945. By the Director. Pp. iii + 37. (London: British Colliery Owners Research Association, 1946.) [298

Forestry Commission Yield Tables for Scots Pine and other Conifers. Pp. 24. (London: H.M. Stationery Office, 1946.) 6*d*. net. [298

Ministry of Health. On the State of the Public Health during Six Years of War. Report of the Chief Medical Officer of the Ministry of Health, 1939–45. Pp. iv + 280. (London: H.M. Stationery Office, 1946.) 5*s*. net. [29

The Place of Research in the Iron and Steel Industry. Pp. 12. (London: British Iron and Steel Research Association, 1946.) [29

Philosophical Transactions of the Royal Society of London. Series B: Biological Science. No. 587, Vol. 232: The Mechanics and Innervation of the Starfish Tube Foot-Ampulla System. By Dr. J. E. Smith. Pp. 279–310. Series A: Mathematical and Physical Sciences. No. 813, Vol. 240: The Calculation of Variable Heat Flow in Solids. By N. R. Eyres, Dr. D. R. Hartree, J. Ingham, Dr. R. Jackson, Dr. R. J. Sarjant and J. B. Wagstaff. Pp. 57. 9*s*. (London: Cambridge University Press, 1946.) [29

Other Countries

Smithsonian Institution: United States National Museum. Bulletin 185: Checklist of the Coleopterous Insects of Mexico, Central America, the West Indies, and South America, Part 4. Compiled by Richard E. Blackwelder. Pp. iii + 551–763. 50 cents. Bulletin 190: The North American Clear-Wing Moths of the Family Aegeriidae. By George P. Engelhardt. Pp. vi + 22 + 32 plates. 75 cents. (Washington, D.C.: Government Printing Office, 1946.) [278

Development and Welfare in the West Indies. Bulletin No. 19: Survey of Animal Husbandry, Feeding, Management and Veterinary Services in the West Indies—Trinidad and Tobago. Report by Prof. Wm. C. Miller. Pp. 40. (Bridgetown: Advocate Co., Ltd., 1946.) 10 cents. [278

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 185: Studies on the Mitchell Grass Association in South-Western Queensland, 2. The Effect of Grazing on the Mitchell Grass Pasture. By R. Roe and G. H. Allen. Pp. 27. Bulletin No. 186: The General Ecological Characteristics of the Outbreak Areas and Outbreak Years of the Australian Plague Locust (*Chortoicetes terminifera* Walk.) By Dr. K. H. L. Key. Pp. 127 + 8 plates. Bulletin No. 191: Studies of the Physiology and Toxicology of Blowflies, 10, A Histochemical Examination of the Distribution of Copper in *Lucilia cuprina*; 11, A Quantitative Investigation of the Copper Content of *Lucilia cuprina*. By D. F. Waterhouse. Pp. 39 + 1 plate. Bulletin No. 193: Post-Miocene Climatic and Geologic History and its Significance in relation to the Genesis of the Major Soil Types of South Australia. By R. L. Crocker. Pp. 56 + 9 plates. (Melbourne: Government Printer, 1945–1946.) [288

Arkiv för Matematik, Astronomi och Fysik utgivet av K. Svenska Vetenskapsakademien. Band 32A, No. 8: Determination of Orbits in the Field of a Magnetic Dipole with Applications to the Theory of the Diurnal Variation of Cosmic Radiation. By Karl Gustav Malmfors. Pp. iii + 64. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co., Ltd., 1945.) [288

Stockholms Observatoriums Annaler. Band 14, No. 9: On the Cosmogony of the Solar System, 3. By Hannes Alfvén. Pp. 29. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.: London: H. K. Lewis and Co., Ltd., 1946.) [288

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 100, Nr. 10: East Greenland Lakes as Habitats for Chironomid Larvae; Studies on the Systematics and Biology of Chironomidae, 2. By F. Sogaard Andersen. (Treaarsexpeditionen til Christian den X's Land, 1931–34.) Pp. 65 + 2 plates. 3 kr. Bd. 121, Nr. 15: The Zoology of East Greenland—Araneina. By Jens Braendegaard. Pp. 128. 5 kr. Bd. 129, Nr. 3: A Grammar of the West Greenland Language. By C. W. Schultz-Lorentzen. Pp. 104. 5 kr. Bd. 130, Nr. 3: The East Greenland Ice. By Lauge Koch. Pp. 374 + 1 plate. 18 kr. Bd. 142, Nr. 2: Effect of the Climatic Amelioration of the Past Decade on the Autumn Change of Coat of the Arctic Fox in Greenland. By K. Faester. Pp. 18 + 2 plates. 1 kr. (København: C. A. Reitzels Forlag, 1945–1946.) [288

Meddelelser om Grønland udgivne af Kommissionen for Videnskabelige Undersøgelser i Grønland. Bd. 144, Nr. 2: On the Hydrography of the Greenland Sea. By A. Kiilerich. (De Danske Expeditioner til Østgrønland, 1926–39, Appendix No. 2.) Pp. 63 + 3 plates. 3.25 kr. Bd. 144, Nr. 3: Summary of the Botanical Investigations in N.E. Greenland. By Thorvald Sørensen. (De Danske Expeditioner til Østgrønland, 1926–39, Appendix No. 3.) Pp. 48 + 1 plate. 2.50 kr. Bd. 144, Nr. 4: Eskimo Settlements in Northeast Greenland. By P. V. Glob. (De Danske Expeditioner til Østgrønland, 1926–39, Appendix No. 6.) Pp. 40. 2 kr. Bd. 145, Nr. 1: Det Denska Sture af Grønland, 1825–1850. Af P. P. Sveistrup og Sune Dalgaard. Pp. 419. 20 kr. Bd. 145, Nr. 2: Grønlaenderne i Danmark; Bidrag til Belysning af Grønlandsk Kolonisationsarbejde fra 1605 til vor Tid. Af A. Bertelsen. Pp. 211. 10 kr. (København: C. A. Reitzels Forlag, 1945–1946.) [288

Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-verbaux des Réunions. Vol. 112: Hydrography. Pp. 94. 6 kr. Vol. 113: Rapport administratif (1939–1942.) Pp. 51. 3 kr. Vol. 114: Die Schollenbevölkerung der Helgoländer Bucht und die Einschränkung der Fischerie während der Kriegsjahre 1914–1918 und 1939–1942. Von A. Bückmann. Pp. 42. 3.50 kr. Vol. 115: International Exploration of the Sea, by Johan Hjort; The Stock of Sea Fishes and the International Convention, London, 1937, by Henry Baels. Pp. 51. 3 kr. Vol. 116: Procès-verbaux (Octobre, 1945); Rapport administratif (1942–43, 1943–44 et 1944–45). Pp. 50 + 53. 6 kr. (Copenhague: Andr. Fred. Høst et fils, 1943–1946.) [288

Catalogues

Double-Telescope Somet Binar 25 × 100. Pp. 4. (Prague: MEOPTA United Works for Fine Mechanics and Optics, 1946.)

Towers Laboratory News. No. 3. Pp. 33–48. (Widnes: J. W. Towers and Co., Ltd., 1946.)

pH at the End of a Pointer. (Bulletin B.569B.). Pp. 4. (Beckenham: Muirhead and Co., Ltd., 1946.)

Ross Allen's Reptile Institute Fall and Winter Catalog. Pp. 20. (Silver Springs, Fla.: Ross Allen's Reptile Institute, 1946.)

Bowes and Bowes Book Bulletin. Autumn 1946. Pp. 16. (Cambridge: Bowes and Bowes, 1946.)

A List of the Publications of the Hakluyt Society. Pp. 16. (London: Bernard Quaritch, Ltd., 1946.)

A Catalogue of Books of English Literature and History, together with Books from Modern Presses. (No. 642.) Pp. 80. (London: Bernard Quaritch, Ltd., 1946.)

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RESEARCH ASSOCIATIONS IN GREAT BRITAIN

IN reply to a question in the House of Lords on December 4, Lord Chorley stated that preliminary discussions had taken place with the wool, building, iron-foundry and silk industries regarding the use of the Defence (Services for Industry) Regulations, 1945, to further industrial research. In general, the development of arrangements of this kind had awaited the reports of the Working Parties set up by the Board of Trade, and all the reports so far received recommend the use of a compulsory levy to support scientific research. He stated that the proposals of these Working Parties on this, as on other matters, would be dealt with under the legislation announced in the King's speech, and which was intended to supersede the Defence (Services for Industry) Regulations.

This statement will be regarded with some uneasiness by most of those concerned with research, whether on the industrial or the scientific side. Of the Working Parties which have already reported, only those for the pottery and the cotton industries showed clear conceptions of the nature of research, and it was the latter report which, recognizing that the research associations had important functions to perform as central research institutes, suggested that it would be useful to review the experience of the whole research association movement. Since that report appeared, those from the Working Parties for the boot and shoe industry and the furniture industry have emphasized the soundness of the judgment of the Cotton Working Party that the right answers are not yet clear to such questions as the nature and scope of the functions of a research association, how they can best be exercised, by what means their exercise can be made of the fullest possible value to industry and how they should be correlated with the functions of individual firms.

The report from the Pottery Working Party in general supports this attitude, although it was concerned rather with one particular research association than with the general question. None the less, it points out that dissatisfaction with a research association might be due to a false conception of its proper functions, and that any vigorous industry with private research establishments moves rapidly ahead of its co-operative research association in knowledge of the application of scientific work. Furthermore, the Pottery Working Party points out that day-to-day problems requiring investigation can be dealt with much more easily and effectively by a competent technical manager or research staff in the factory itself, and it recommends firmly that the research association itself should distinguish its day-to-day technical consultation from its fundamental research, and should on no account fail to make provision for the latter. Finally, after admitting that a very small levy for co-operative research may be a proper charge on every substantial firm in the industry, particularly if a research association limits its work to fundamental problems, it is reiterated that a research association cannot justify itself until an adequate body of research workers is employed privately by manufacturers to form a bridge between the association and the industry.

No such clear conceptions characterize the report of the Working Party for the furniture industry. It is admitted that the industry in the past has paid insufficient attention to research, that the vast majority of the firms have no research organisation within their factories, and that this neglect has been one of the causes of the stagnation in design. It is recommended that a research association for the industry be established, and also that individual firms should, wherever possible, set up their own research units; but the functions suggested for the proposed research association demonstrate a very inadequate conception of research. The research association, it is suggested, should have as its main functions the formulation of the industry's research problems, and undertaking them or placing them with appropriate outside organisations. Next, it should take steps to bring to the notice of the industry the results of all research work undertaken on behalf of the industry. It should also be responsible for examining scientific publications for information likely to be of interest or of use to the industry, and for bringing such information to the attention of its members. Finally, the research association should be responsible for running the independent testing station connected with the proposed minimum standards scheme, as well as for carrying out the research required to establish standard performance tests.

The contrast between these views and those urged by the Pottery Working Party is seen finally in the contention by the Furniture Working Party that the function of a research association is primarily technological and secondarily 'fundamental'. Admittedly the Furniture Working Party was concerned with an industry where the organisation and equipment for research have largely to be established, and it rightly has in mind the possibility of utilizing the existing laboratories and institutions of the Department of Scientific and Industrial Research, for example, the Forest Products Research Laboratory and the textile research associations, especially while the new association is formulating its programme and building up its own facilities. The formulation of a research programme is the first stage, but is largely a matter for the industry itself; and only when such a programme has been formulated at least in broad outline can it be clearly seen what contribution a research association could make, how far the problems to be solved involve co-operative effort and investigations into the fundamental sciences on which the industry must draw, and what facilities must be provided to supply those needs.

No definite proposals for financial support of a research association can well be put forward until a research programme is available, and this is all the more important in an industry which relies so much on tradition. Here the experience of the building industry, another 'traditional' industry, may prove of some help. What must be remembered is that an educational campaign will be necessary to secure the requisite support for a research association scheme. To inform the industry is a first task, and although an information department is an important and indeed essential element in the working of a research association, its functions must be directed primarily to the service of the research department's own needs and not to the broadcasting of information to the industry as a whole. The task of extracting and circulating items of interest from published information requires the help of information officers, if not sections, within the individual firms themselves, and until firms are equipped, at least by the presence of sufficient scientific and technical men and women on their own staff, to utilize the available information presented to them, the efforts of a research association in selecting and circulating such material are likely to be of little value. This preliminary task of education is of fundamental importance.

In an article on "Cultural Understanding and Appreciation of the Scientific Approach" in *Science* of October 11, 1946, R. H. Ojemann makes a point which is often overlooked in this connexion. He presents evidence that the function of research is not well understood either by leaders of the community or by students leaving school, and although he is concerned primarily with the fact that research is not in consequence considered as an important function in society or regarded as a valuable method of solving social problems, his main point is of wider significance; namely, the absence in the community of sufficient knowledge of the nature of scientific research, of the probability character and limits of knowledge, and of the constant changes in our knowledge, constitutes a grave danger to the support of scientific research in a democratic society.

While this condition obtains, there is not only difficulty in obtaining adequate support for research, but also a continuing risk that such support may be suddenly and capriciously withdrawn. The bearing of this on what may be termed scientific information services is rarely appreciated. The dissemination of information is commonly directed to the circulation of information on scientific findings. Too few attempts are made to promote understanding of how dependable knowledge is obtained, what it costs in effort, as well as money, to establish scientific results, and the handicaps imposed by the present limits of knowledge.

It is on such points as these that the educational work preceding the establishment of a new research association should be concentrated; if more effort were directed to such ends rather than to the mere dissemination of scientific knowledge, we should be nearer to finding the right answers to the questions emphasized by the Working Party for the cotton industry. Moreover, the research associations themselves would be in a much better position to make their full contribution to industrial efficiency; and they should in fact become the more conscious of their great responsibilities so long as misconceptions persist in the community as to the contribution which research can offer to the solution of such problems as the housing shortage, the coal shortage, or the restoration of the cotton industry to a condition to meet future world competition.

There is, in fact, no need for the research associations to adopt the defensive attitude which characterized contributions to a recent conference in Manchester on "Research and the Smaller Firm". Co-operative research on certain aspects of industrial problems needs no defence. The universities should not, and the Government laboratories cannot, engage in research work of the usual *ad hoc* industrial type, which has as its prime motive the desire of the participating firm to increase its competitive position. But the research association is only one of the ways in which industrial research can be prosecuted, and indeed depends for its full effect, as the Working Parties have realized, upon the existence of active research departments in the individual firms themselves.

There is here another factor to be considered. While there may be other means to be explored besides the research association method for prosecuting research which a firm has neither the staff nor the equipment to carry out in its own laboratories, there is an undoubted *prima facie* case for pooling resources in a central research association for ambitious, long-term projects of fundamental and probably highly speculative type. In order to gather the full fruits of such pooling, however, the central research body must be competent to conceive and plan the approach to targets in such fundamental research; and the subscribing firms must be provided with research units at the points of production, so as to facilitate the proper application of the results.

Now in industry the ability to plan successfully long-term research has only evolved gradually, from experience in the conduct of less ambitious projects. If, therefore, a research association is to plan such research, and select appropriate objectives and the men to carry out the projects, leaving them to carry out their investigations with the minimum of interference or 'management', it will require to be as strong on its technological as on its scientific side. Here lies the critical problem before the research associations to-day, namely, commanding the services of research workers of the requisite experience, energy and creative powers. It is a question of man-power, of having available scientifically and technically educated men capable of taking the highest positions in each of the three primary functions of industry—research, production and selling.

That much has been clearly grasped by the Working Party for the jewellery and silverware industry. While its comments on the indifference or even hostility of the industry to research and design, and its recommendations regarding its proposed design and research centre, which the Board of Trade and the Department of Scientific and Industrial Research are already engaged to support, are broadly parallel with those of the Furniture Working Party, this report proceeds: "It is also plain to us that the close and sensitive contacts required between the Centre and the many firms engaged in commercial production will not be established and maintained, unless a good number of these firms can be induced to recruit and absorb men of broad scientific education and wide technical training in positions of good standing".

No Working Party has yet stated explicitly, however, that the criterion of progressive industry is the ability at board level to direct its research work with the same acumen and efficiency as are applied to production and sales. On this point it might be suggested that leaders in some of the industries which have hitherto been unmindful of research might study with profit the early history of such an industry as the dyestuffs industry, in which research is admittedly a keystone in its structure. It is probably with the idea of assisting in training men with a scientific outlook and experience in research, and the permeation of industry with them until they reach the top, that the Cotton Working Party was led to recommend the establishment of industrial research fellowships and associateships, a plan for which was set forth in some detail in an annexe to its report. The ultimate object of the scheme is to establish a body of experienced research workers within the industry itself, although it visualizes a research foundation having on its staff research fellows and associates whose services could be made available to firms requiring them.

While it is essential for the research associations themselves to secure both an inflow and an outflow of trained research workers, moving between the associations and the industries they serve, there is little evidence in current discussions that either the research associations or the Department of Scientific and Industrial Research are sufficiently alive to the importance of this matter. To accelerate the training of such men and to facilitate the permeation of industry by them are the vital tasks: a system of liaison officers is dilettante trifling with the issues. The Department of Scientific and Industrial Research has indeed already assisted many science graduates of the universities to undertake the post-graduate training which should fit them to undertake research; but there is still much to be done on these lines before the status of some of the technical faculties is raised to that of research schools. If the Department, through its research associations and in other ways, is prepared to assist such developments and to try new ideas and new methods, it will promote a flow of men with a research outlook and a technical background, it will bring new knowledge to the technological field, and will also infuse new vitality into the research associations themselves and place them on the firm foundation of proved service rendered to the industries with which they are linked. Every consideration which increases the importance of a wise and efficient use of our limited resources of scientific man-power makes it the more imperative that, before any large new schemes involving the employment of numerous scientific workers either in research or in other capacities are launched, we should do our utmost to expedite this interchange between industry and the universities and other institutions where fundamental research is pursued. In this way we can ensure that industry is fully prepared to utilize the new knowledge which a new organisation might provide.

SCIENCE AND STOCKBREEDING

Animal Breeding

By Dr. A. L. Hagedoorn. (Agricultural and Horticultural Handbooks.) Second edition. Pp. 304+15 plates. (London: Crosby Lockwood and Son, Ltd., 1946.) 15*s.* net.

The Milch Cow in England

A Plea for Constructive Breeding. By E. R. Cochrane. Pp. 348+16 plates. (London: Faber and Faber, Ltd., 1946.) 16*s.* net.

DR. HAGEDOORN'S book is a second edition of one first issued in 1939, reprinted four times, and now emerging as a further contribution to the field of genetics applied to livestock improvement; Miss Cochrane's is an entirely new analysis of problems of cattle-breeding in Great Britain. The texts are alike in that they are intended to stimulate, and the authors' techniques are somewhat similar in that they both attack some of the vested beliefs and interests in stockbreeding and, rather unfortunately, find it necessary to repeat statement and argument too much and too often. But there resemblance ceases, and the effects of the stimuli differ; Dr. Hagedoorn sets out to be educative and ends in being provoking, Miss Cochrane to be critically provocative and becomes distinctly educative.

Moreover, the authors' backgrounds are in great contrast. Dr. Hagedoorn has come by what might fairly—nowadays—be called the easy road to an exposition of applied genetics: from small-animal breeding, via poultry, past some view-points of possible applications in the larger animals to a stance from which an almost complacent dogmatism can be readily enunciated for the benefit of stockbreeders and students eager to add something from the new science to the old art. The process of instruction is to some extent simplified, if the results of recent work and their implications are not appreciated; and the clarity of presentation becomes more superficial. Now, in one sense Dr. Hagedoorn has served a useful purpose. In 1939 there were few simple texts available to arouse the practical man's interest in applied genetics, and his almost conversational, almost inconsequential, style held attraction to the acquisitive reader. His book was, is, and this new edition no doubt will be, widely read. There lie the dangers.

Even allowing for the difficulties and the distressing isolation under which Dr. Hagedoorn has pursued his own work since 1939 (and from which we, together with many other animal breeders and geneticists, welcome his safe reappearance), it must be said fairly that the slight annotations by which this edition differs from the first do not remove its weaknesses, confusions and misleading statements. These are too numerous to specify here; however, the insistence on the presence and absence idea was inept even in 1939, and to use the reduction in number of ancestors as a measure of inbreeding is outmoded, to say the least; the discussion of domestication and adaptation is confused and not always plausible. Further, the author's own arguments for progeny-testing and his 'nucleus scheme' of breed improvement on the basis of genetic uniformity are not very convincing or acceptable, and should be re-examined in the light of recent genetical work and practical requirements. Dr. Hagedoorn's text, therefore, provokes not only criticism at many points but also serious concern that, having been widely read, it has apparently been accepted by many readers as a completely authoritative statement of modern genetics in relation to stockbreeding.

Fortunately, Miss Cochrane is not one whose approach is limited to that signposted by Dr. Hagedoorn. She has come by the hard road from dearly bought experience in pedigree cattle-breeding, through the doubts and disappointments of hoping that pedigree and practice might give performance and efficiency, to a point at which a critical exploration of many routes was needed. She has obviously made wide reconnaissance of the possibilities of collecting material for a sound path for the future from the fields of physiology, economics, nutrition, genetics and practice. Here is a frankly personal, often outspokenly critical, but always well documented, inventory of what she has found so far and hopes may come.

The result is extremely provocative; the reactions are bound to be varied in intensity as well as kind, according to the reader's vested interest or predilection. But surely, no matter how annoyed, disturbed or sensitive, no one should accuse Miss Cochrane of complacency, of intellectual dishonesty, or of narrow-mindedness, except in so far as she is determined to improve the average cow of the average breeder in England (and Scotland and Wales and everywhere!), perhaps too quickly, but ultimately. No two readers will agree. Her own criticism is given, so that she obviously invites it, in her turn, especially if it can be constructive and would help her to rewrite in some future edition the last three chapters ("Enterprise and the Breeder"; "Security and the Farmer"; "The Responsibility of the State").

Unity of aim, absence of humbug and close cooperation of scientific workers, administrators, breed societies, breeders and the State, she sees as essentials towards the establishment of a sound progressive (*not* static), efficient and satisfactory cattle industry. We are confident that Miss Cochrane herself would be well satisfied if she could find the average great-great-granddaughter of the present average English cow a higher producer of a better quality milk over a longer, healthier life-time, even if she had to withdraw some of the contentious and perhaps extravagant conclusions she now makes. Meantime, we feel that the almost impetuous presentation of the case should not be met with any impetuous reaction, but should be widely read and considered as indeed "a plea for constructive breeding". J. E. NICHOLS

METALLURGICAL ATOMS

Atomic Theory for Students of Metallurgy

By Dr. William Hume-Rothery. (Institute of Metals: Monograph and Report Series, No. 3.) Pp. viii+286. (London: Institute of Metals, 1946.) 7*s.* 6*d.*

"EXPERIENCE has shown," Dr. Hume-Rothery cautiously remarks, as though introducing a statement which would arouse incredulity, "that students of metallurgy are greatly interested in the new theoretical work [on the structure and properties of metals and alloys] but are often quite unable to understand the papers or text-books written by mathematical physicists." In this book, therefore, he has attempted to provide a bridge by means of which the student of metallurgy may be led to an understanding of the general ideas on which the modern theory is based. He can be assured that students of metallurgy, though they may sometimes suffer from the peculiar disadvantages of unimaginative and narrowly conceived technological types of training, are not alone in their misfortunes. An easy path through difficult terrain is likely to be gratefully used by many others than those for whom it was primarily made. The path here is skilfully constructed, and it affords an admirable view of many of the most interesting superficial features of the region, as well as occasional glimpses of details of the underlying structure.

The book gives the most comprehensive survey of the modern electronic theory of metals that has yet been made with so limited a use of mathematical technique and symbolism. The thirty chapters are grouped in six parts, the first three of which, dealing with the general background, the structure of the free atom, and assemblies of atoms, outline the basic atomic theory. After a very brief review of the classical and the original Bohr theory of atomic structure, the presentation is almost entirely from what may be called a descriptive wave mechanical point of view. Considerable attention is given to methods of representation of electron-cloud density, and when 'pictures' of atoms are given, their limitations are adequately stressed. There is an excellent chapter on the soft X-ray spectra of solids, a field of investigation the potential importance of which is not yet widely appreciated. This first half of the book may be commended to all those who wish for a non-mathematical introduction to modern atomic theory. Only occasionally is there a looseness of phraseology, to which the supersensitive might make the objection that a wrong impression could be conveyed. It will be sufficient to give, without comment beyond italicizing, one example taken from p. 52, where it is stated, "It might at first be thought that the normal state of every atom would be such that all the electrons occupied the lowest quantum state. Actually, however, this is not the case, *owing to the effect of* what is known as the Pauli Exclusion Principle."

The second half of the book is concerned with the application of the general ideas to the theory of metals. Fermi–Dirac statistics and the free electron approximation are described, and a good general account is given of the Brillouin zone treatment. In the last part a systematic survey is made of the bearing of the theory on the interpretation of the properties of the metals of the first column of the periodic table and their alloys, of representative metals of higher valency and crystal structures other than cubic, and of the elements of the first transition series. Sections are included on a number of special topics, among them being specific heat, Pauling's theories, and electron bands in iron. The concluding chapter gives a brief account of magnetic properties. Throughout this part of the book the author's discussion and assessment of the achievements of wave-mechanical theory is of particular interest and value owing to his wide and detailed knowledge of alloy systems, to the clearer understanding of which his own work has contributed so substantially.

Almost every paragraph of this book bears evidence of the care and thought which have been expended to write of the basic ideas of wave-mechanical theory and of its application to the interpretation of the properties of metals in a way that shall be intelligible to an honours student of metallurgy of limited mathematical attainments. The author has carried out admirably the plan he seems to have had in mind, and for this reason the book is rightly assured of a wide welcome.

The book should not be regarded as a substitute for the more mathematical text-books, but rather as a commentary on them. It would be most unfortunate if a student of metallurgy, or any other reader, were to gain the impression that an understanding of the essentials of the quantum mechanical theory of metals could be gained by a perusal of this book alone; yet there is practically no guidance, even by reference, to the now fairly numerous good text-books on the theory of a more mathematical but still fairly elementary character. Hume-Rothery, in attributing the inability of the student to understand such books to "the failure of the mathematician to appreciate the difficulties of the non-mathematical reader", overlooks two much more essential points: first that it is the physical world which it is so difficult to understand, and second that the nearest approach to understanding is that provided by a theory which is most conveniently expressed in mathematical language, and which must be so expressed if effective development is to be possible. Those who wish to understand the theory must be prepared to make the effort necessary to acquire at least a reading knowledge of the language. They should not be led to suppose that an appreciation of some of the highest flights of human genius in the scientific exploration of the world can be gained by an approach as effortless as might be required for 'a bed-time story for tired metallurgists'. This book is certainly no bed-time story, but it does share some of the characteristics, including the good ones, of a Lamb's Tale. It may well have been thought that the title would indicate sufficiently the degree of adaptation.

E. C. STONER

NUCLEAR PHYSICS

Fisica nucleare

Dalla pila di volta alla pila atomica. Per Plinius Campi e Aldo Rusconi. Pp. viii + 215. (Milano: Ulrico Hoepli, 1946.) 400 lire.

La scissione nucleare dell'uranio

Fenomenologia generale. Per Dott. Emidio Prata. Pp. 160. (Milano: Ulrico Hoepli, 1946.) 250 lire.

THE arrival of scientific books from Italy is a welcome sign of the return, in some measure, to more normal conditions in scientific life. It is apparent that the production of the two books under review must have represented a considerable effort in the face of shortages.

It is therefore particularly sad to discover that the contents of the book on nuclear physics are scarcely worth such an effort. The authors deserve congratulations for the ingenious sub-title: "From the Volta pile to the atomic pile", but the praise has to end there. Between the first chapter on Volta (which does not explain Volta's pile) and the last one on atomic energy (which contains a very misleading account of the atomic pile and atomic bomb), an assortment of chapters, some philosophical, some popular descriptions, range over a variety of subjects. Mixed up in them is a new theory, due to one of the authors, according to which space consists of points and antipoints; this theory, we are told, leads to a geometric interpretation of quantum mechanics. A large number of minor and major errors indicate that the authors are not too familiar with modern theoretical or experimental physics.

Dr. Prata's book on fission is on a different level altogether. It attempts to summarize the work published on this subject up to 1943, to which is added a brief abstract of the Smyth report. While the preface does not explain the history of the book, one gains the impression that the manuscript must have been ready some time before the news of the atomic bomb was released, and that the final chapters were added later. However that may be, this book is not one of the many superficial accounts that are trying to exploit the publicity value of atomic energy; it is a serious piece of work intended for the physicist who has kept up to date in modern developments and wants to collect the information on fission without going through all the original papers. A first historical chapter reconstructing the steps leading to the discovery of fission is followed by chapters on fission products, on the energies and masses of the fragments, their passage through gases. A chapter on the theory gives a very readable account of the stability calculations and an outline of the Bohr–Wheeler theory which is somewhat less successful. A chapter on secondary neutrons, a brief mention of Feather's proof of instantaneous fission, and a discussion of data on cross-sections conclude the review of the older literature. The rest of the book consists of a short summary of the Smyth report on the American project, and an almost complete bibliography up to 1943.

This bibliography and the comparative discussion of the early papers will remain useful even though the release of American, British and Canadian work from secrecy is bound soon to make this book obsolete as an account of current knowledge. The author has missed a few points in the Bohr–Wheeler theory and one or two major ones in the Smyth report, but otherwise the book is instructive, and, for the physicist with some knowledge of nuclear physics, very readable.

R. E. PEIERLS

BIRDS OF NORTH AMERICA

Audubon Bird Guide

Eastern Land Birds. By Richard H. Pough. (Sponsored by National Audubon Society.) Pp. xxxvii+312+48 plates. (New York: Doubleday and Co., Inc., 1946.) 3 dollars.

ORNITHOLOGICALLY speaking, North America is divided into four areas—western, eastern, middle America and the West Indies, the largest being the eastern one that includes the Atlantic seaboard. Mr. Pough writes of the birds of this area under the title of "Audubon Bird Guide—Eastern Land Birds". He deals with the 275 species of land birds found in eastern North America in a concise manner, most helpful to the recent recruit to ornithology. His remarks under the heading of "Identification" are excellent, for he seizes on the outstanding characteristics of each species and tells the field worker what to look for. The colour portraits are also good and helpful, though it is to be regretted that no indication of scale accompanies them. If one did not know otherwise, one might imagine that the snowy owl is no bigger than the English sparrow, the picture of which is most life-like; however, in most cases all birds on a plate are drawn to the same scale.

The foreword will be read with appreciation by ornithologists of both New and Old Worlds, for it contains much of interest and many practical common-sense hints for the beginner, also he who no longer comes under this heading. The remarks on psychology and behaviour give food for thought. "The study of birds has been greatly handicapped by a tendency to interpret their behaviour according to human standards: This is a mistake. Birds are creatures of instinct, and the whole pattern of their lives is determined in advance by their inheritance. They have no power of thought as we understand it. Apparently a newly hatched bird inherits everything it needs to carry out every step in its life cycle, even when it includes long migration flights, elaborate nest-building, or any one of hundreds of other equally complex performances." The author goes on to say, "Birds are no less fascinating because they act like automatons; that is, like birds instead of people".

Although Mr. Pough is certainly correct regarding the birds' inherited patterns of behaviour, maybe his generalizations are somewhat too sweeping. For example, anyone who has had dealings with a tame raven will find it difficult to dispense with the word 'intelligence' in any analysis of its conduct. Is it automatonism when it tweaks the cat's tail?

FRANCES PITT

PLANT TISSUE CULTURE

Une voie nouvelle en biologie végétale

La culture des tissus. Par R.-J. Gautheret. (L'Avenir de la science, No. 21.) Pp. 202+32 plates. (Paris: Libr. Gallimard, 1945.) 190 francs.

THE technique of culturing animal tissue *in vitro* has, on many occasions, received considerable publicity. No comparable public interest has been centred on the cultivation of plant tissues, yet in many ways the results have been at least as important. In animal tissue culture the media used have normally contained tissue extracts and serum, and attempts to produce purely synthetic media have so far met with little success. Media used in plant tissue culture, on the other hand, have in the main been synthetic, and it is not surprising, therefore, that successful continued proliferation of undifferentiated plant tissues *in vitro* have been achieved only within the last eight years. Most of the successful advances have been made in France or the United States, and in the former country the technique has been developed primarily by R.-J. Gautheret. It is, therefore, with considerable interest that one turns to his account of the subject.

After a historical introduction, the writer discusses the principles and problems of the techniques used, and then goes on to consider the morphological characters of the cultures obtained. Chapter 4 deals with the problems of the physiology of the growing tissues, and the final chapter with the possibilities of the technique.

The account of the methods and results is admirable, and the work is well illustrated with excellent plates and good figures; but the deliberate omission of references detracts considerably from the book and tends to damp interests stimulated by the text. Gautheret has made it abundantly clear that the cultivation of plant tissues has immense possibilities, and although many difficulties remain to be surmounted the future of the technique is assured.

ALAN BURGES

HISTORY OF ALCHEMY AND EARLY CHEMISTRY*

By Prof. J. R. PARTINGTON, M.B.E.
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THE history of alchemy should properly begin with a survey of the technical arts of the ancient nations. Archæological discoveries show that these arts were highly developed about 3500 B.C., so that they must have arisen earlier. Later on they declined, and in Egypt, by the beginning of the Christian era, had mostly deteriorated into an imitative technique, although in some cases, as in the manufacture of glass, there had been advances. The precious metals and gems had been replaced by base alloys and coloured pastes.

Alchemy is a growth which appears suddenly in Egypt about the beginning of the Christian era, and at first sight seems to have no roots. Its origins were long surrounded by a veil of mystery. Its earliest name, the 'Divine Art', points to its supposed origin in a divine revelation by fallen angels, a tradition embellished in Jewish works like the Book of Enoch, and in some Greek alchemical texts. In the latter, it also appears as a revelation by the god Hermes Trismegistos, the Hellenistic form of the ancient Egyptian god Thoth, and hence alchemy was sometimes called the 'Hermetic Art'.

In its earliest period, and for long afterwards, alchemy meant the practical art of making gold and silver. It had also certain theories, or dogmatic rules, the most important being a belief in the essential unity of matter, and the possibility of converting one form of matter into another by suitable treatment. These theories originated in the speculations of Plato and Aristotle.

The view that the chemical elements are permanent and unchangeable was only generally adopted, on an experimental basis, at the end of the eighteenth century, the possibility of transmutation having been accepted, for example, by Boyle and Newton. The doctrine of the permanence of the elements was a necessary step in the development of chemistry, and the alternative view could not receive any experimental basis until quite recent times.

The atomic theory, another achievement of Greek genius, is unfavourable to alchemy, since it pictures the elements as aggregates of particles of different species which are permanent for all time; and it is noteworthy that the early alchemists make no use of it. Although Demokritos, the founder of the atomic theory, may be said to be also the founder of modern chemical theory, the master of the alchemists was Plato.

So far as is known, Western alchemy arose about the beginning of the Christian era in Alexandria, from the joining of two streams of knowledge; the first of these was the ancient Egyptian art of working metals, and the second the theoretical views on the nature of matter taught by Greek philosophy.

In A.D. 296 the Roman Emperor Diocletian issued in Alexandria an edict ordering the books of the Egyptian forgers teaching the preparation (that is, imitation) of gold and silver to be burnt whenever they could be found. One such book appears to be the Papyrus of Leyden, found in 1828 buried with a mummy in Egypt. It was written in Greek about Diocletian's time, and contains the working notes of a fraudulent goldsmith. It deals with the imitation of precious metals so as to 'deceive the expert', as it says, including the plating of copper or silver with gold (by treating with gold amalgam and heating to drive off the mercury), and with making imitation silver from tin. Another part of the same work, the Stockholm Papyrus, treats mostly of the imitation of gems and valuable dyes, such as purple. Some Assyrian cuneiform tablets of 650 B.C. also describe the imitation of lapis lazuli by blue glass coloured with cobalt, some specimens of which have been found.

In these papyri there is no suggestion that the products were more than clever imitations. Alchemy, which assumed that real gold and silver could be obtained, arose from Greek philosophical ideas. These, as understood by the alchemists, postulated a primary matter, or *hulē*, on which a form, or *eidos*, could be impressed so as to give a specific body such as lead or gold, which was an association of primary matter and form. If lead could be divested of its specific form, and the form of gold impressed on the primary matter (the same in lead and gold), then gold would result.

A subsidiary idea of Chaldæan and Persian origin supposed that metals are formed in the earth by the action of rays or effluences from the seven planets, each producing a particular metal. Astrology, which has been described as an organised body of error, thus became the sister of alchemy; but in practical alchemy its influence was mainly confined to the use of the planetary names and symbols for the metals: gold and the sun, silver and the moon, copper and Venus, and so on.

Suitable starting materials for transmutation were supposed to be lead, which was easily 'mortified'; or a yellow alloy of lead and copper (a lead bronze, known in ancient Egypt and Babylonia), called *molybdochalkos*; and also mercury, since Plato had taught that metals are formed from water, and this *hydrargyros*, or silver-water, was thus very near the primary matter of metals.

The earliest alchemical texts are in Greek, and go back to the first two or three centuries A.D. In them the subject is called the 'Divine Art'. The name 'chemistry' (χημεία) came somewhat later, about 300 A.D. It is probably derived from the old name for Egypt, *Chem*, found in hieroglyphics and known to Plutarch, which means black, from the black colour of the alluvial soil. The texts abound in obscure words, and what is worse, in common words used in a very uncommon sense. We are told to take "the bile of the serpent which is the divine water"; but in another place this is said to be made by boiling sulphur with milk of lime. The divine water (θεῖον ὕδωρ) is a solution of calcium polysulphides.

The earliest author is Demokritos—not the old Greek philosopher, Demokritos of Abdera, but a writer of the first century A.D. His main work, "Physical and Mystical Matters", begins with some recipes for imitating purple in the style of the Stockholm Papyrus, but suddenly breaks into a story of an invocation of the shade of the dead master, the Persian Ostanes, and the subsequent discovery of an inscription revealed by the opening of a pillar in a temple. This inscription merely said: "Nature rejoices in nature, Nature conquers nature, Nature overcomes nature". "We were much surprised," says Demokritos, "that he had comprised all his teaching in so few words." These words may express the fundamental alteration of specific property (φύσις, nature) by what Aristotle had already recognized as chemical change, and distinguished from mechanical mixture. No chemical apparatus is described.

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* Based on three lectures at the Royal Institution on October 31, November 7 and 14, 1946.

Two other early authors are Maria the Jewess, probably a real person from Jerusalem, and Cleopatra the Egyptian, who is otherwise known as a writer on weights and measures and on cosmetics. Maria, probably in the first century A.D., invented the earliest apparatus for distillation, and an instrument called the *kerotakis*. The *ambix*, used for distillation, was originally a kind of spouted jug. She describes the making of an *ambix* from thin sheet bronze, "in thickness little more than that of a frying pan for cakes", comprising a vertical tube, a head, and three outlet pipes, all carefully soldered. This piece, later called the helm or head, was luted to a glass or earthenware body, called a *lopas*, later called the *cucurbit*, or *aludel*, and the whole was heated by lamps or a small fire, the products of distillation being received in small phials. The *kerotakis* apparatus comprised a small brazier such as was used by encaustic painters for keeping the coloured wax melted (hence the name), and a small heated plate with cup-shaped depressions, such as was, and is, used for cooking eggs, but was probably the palette used by encaustic painters. The apparatus was used for sublimation, the vapours being condensed on a small bell-jar inverted over the palette. So cinnabar was made by sublimating sulphur and mercury, white arsenic obtained by roasting the red and yellow sulphide minerals, and called 'white alum'; the element arsenic itself was formed by reduction, and called the 'second mercury'.

Cleopatra's work, called the "Chrusopoiïa", or the making of gold, is a page of symbolic drawings. The dragon Ouroboros, engaged in eating his own tail, surrounds the legend: ἓν τὸ πᾶν ("one the all"); and the planetary symbols share the space inside concentric circles with the maxim in Greek: "One is all, and through it is all, and by it is all, and if you have not all, all is nothing". The distillation apparatus appears.

The process of transmutation was effected by a powder called *xerion* (ξηρίον), the contemporary meaning being a cosmetic or dusting powder. The name became the Arabic *al iksir*, or *elixir*, another name for the Philosophers' Stone. The transmuting process was also likened to dyeing, or a tinctorial process, and the Philosophers' Stone was called the *tincture*.

The most copious Greek alchemical author is Zosimos of Panopolis, A.D. 250–300, of whom a commentator admiringly says: "His words are as abundant as the ocean". His twenty-eight treatises were addressed to his 'sister' Theosebeia, a lady of rank, "clothed in the purple", and probably a member, or 'sister', of a small study-circle. Zosimos classifies things into *bodies* (metals), and *spirits* (πνεύματα), "certain substances which are by reason of their nature invisible", namely, the vapours of mercury, arsenic, and sulphur, which he also calls 'vapours' or 'smokes', as do later Arabic authors. He came near the recognition of gases. His works contain some remarkable visions which have engaged the attention of the psychoanalysts.

Besides the Demokritan school, there are traces of others: Zosimos sends his malicious regards to a priest Neilos, and his 'sister' Paphnutia, who wasted a day in roasting a mineral in a common kitchen fireplace instead of in a *kerotakis*, and got nothing but a heap of ashes. They had omitted the bell-jar to receive the sublimate.

After Zosimos, the treatises are mostly commentaries. The last author is Stephanos, a court professor at Constantinople, whose works are largely rhetorical.

The Saracen conquests of the seventh century A.D. shifted the stage of alchemy to Syria and Mesopotamia, where it was known as *al kimiya*, the old name being retained. The Greek works of Demokritos and Zosimos appeared in Syriac translation, some of which are extant.

Saracen alchemy is mainly linked with the names of Jābir ibn Hāyyan, known in the West as Geber, about A.D. 750; al-Rāzī, known in Europe as Rhases, a Persian physician, A.D. 866–925; and the physician ibn Sina, or Avicenna, A.D. 980–1036. The Latin works attributed to Geber, which long passed as a translation from Jābir, belong to a later date, and even the authenticity of the quite different Arabic works of Jābir has been called in question.

An Arabic work on alchemy, the "Secret of Secrets", attributed to al-Rāzī, has been translated by Ruska. An important Latin work on alchemy, the "de Anima", attributed to Avicenna, was known to Roger Bacon. It seems to have been compiled in Spain from Arabic sources about A.D. 1140. Avicenna was really a critic of alchemy. In a genuine work, the "Book of the Remedy", he says it is not in the power of the alchemists to bring about any true change of metallic species. They can produce imitations so as to deceive even the most expert, yet in these the essential nature remains unchanged.

This criticism was often added to the fourth book of Aristotle's "Meteorology" in Latin translations from Arabic, and was often attributed to Aristotle himself. The passage attracted the attention of the Schoolmen of the thirteenth century, and alchemy became a subject of interest to them.

Albertus Magnus (1193–1280) gives a good summary of alchemy in his "de Mineralibus", in which he mentions the frauds of Paris alchemists. He says alchemical gold, although it stood six or seven ignitions in the fire, was at last turned into dust. Albert, like Roger Bacon, believed in the possibility of alchemy on philosophical grounds; but the treatise on alchemy called "Semita Recta", or the "Straight Path", attributed to him and printed in his works, is spurious.

Roger Bacon (1214–92) divided alchemy into: (i) theoretical or speculative, which treats of the generation of things from elements, and of all kinds of metals, minerals, etc., of which Aristotle and the Latin authors were ignorant; and (ii) practical or operative, which teaches how to make gold and other things better by art than in Nature, and also powerful medicines by sublimation, distillation, etc. Bacon, and also Arnald of Villanova (1240–1311), emphasized the importance of chemistry in medicine long before Paracelsus. Ramon Lull, or Raymund Lully (1233–1316), attacks fraudulent alchemy in his works; a large alchemical literature attributed to him perhaps originated in his school soon after his death. St. Thomas Aquinas, who also had spurious alchemical works attributed to him, discusses in his genuine works the propriety of proffering alchemical gold in payment of debts, concluding that it is lawful if the artificial gold will pass the tests of the goldsmith.

Although the Schoolmen soon lost interest in alchemy, which most of them regarded as fraudulent, the less learned were much attracted by it, and great numbers of people began to study it practically. The paintings of the Dutch schools, especially, show the alchemists at work. Numerous works on alchemy appeared in the fourteenth and fifteenth centuries. Many of these works treat of the supposed mystical aspects of alchemy, a branch which seems to have owed much to Jewish sources, with their preoccupation with anthropocentric diagrams, and the mysteries of the macrocosm and the microcosm.

The "Mirror of Alchemy", wrongly attributed to Roger Bacon but probably almost contemporary, says: "Alchemy is a science which teaches how to make a certain medicine called elixir, the which when it is cast upon metals or imperfect bodies fully perfects them by mere projection. . . . The natural principles of mines are mercury and sulphur. All metals and minerals, of which there are many kinds, are begotten of these two; . . . Nature always intends and strives to the perfection of gold, but many accidents coming between change the metals. . . . For according to the purity or impurity of the two aforesaid principles, mercury and sulphur, pure and impure metals are engendered."

This theory appears in the Saracen authors, and has been attributed to Jābir. It is almost implied in, and seems to be based on, a passage in Aristotle's "Meteorology", in which the formation of metals from two vapours in the earth is expounded.

The alchemists, with their green dragons, red lions, black crows, roses, lilies, and salamanders, feature in literature as well as in art. Chaucer (1345–1400) and Ben Jonson (1572–1637) have much to say about them. English alchemical writings were Thomas Norton's "Ordinal of Alchemy", in verse, supposed to have been written in 1477, and Ripley's works in verse. These are included in Ashmole's "Theatrum Chemicum Britannicum" (1652). Davy correctly says of Ripley's poems that "there is nothing in them which can instruct or amuse an intelligent reader".

Although some alchemists were charlatans, others were sincere, and by experiments, although they never made gold, discovered many useful things like the mineral acids, and pointed the way to a richer knowledge.

Alchemy also flourished at an early date in China, the most celebrated Chinese alchemist being Ko Hung, in the fourth century A.D. Distillation was known, and the Philosophers' Stone, called the *tan*, was supposed to be the elixir of life. Great interest was taken in the synthesis of red cinnabar from mercury and sulphur. Alchemy was also studied in India, where the atomic theory was taught at a fairly early date.

Although Roger Bacon and Arnald of Villanova in the thirteenth century had emphasized the use of chemistry in medicine, this first became important with Paracelsus, born in 1493 at Einsiedeln in Switzerland. After a wandering life, in which he acquired information on alchemy and medicine, he occupied the chair of medicine at Basle for the single session 1527–28. Thereafter he led an unsettled life, dying at Salzburg in 1541. He was a reformer of medicine, and his contributions to chemistry are slight. He believed in the four elements, but thought they appeared as the three principles, or *tria prima*, of salt, sulphur, and mercury, the first being added by him to the two alchemical principles to denote the principle of fixity and incombustibility. Paracelsus gave the name 'alcohol' to spirit of wine.

Van Helmont (1577–1644), of Brussels, whose writings were published by his son in 1648, adopted some views of Paracelsus, but criticized others. He believed that water is the fundamental element, and tried to prove this by growing a tree from a weight of 5 lb. to 200 lb., supplying it only with water. He overlooked the carbon dioxide in the atmosphere, although he was the first to recognize this, calling it *gas sylvestre*, and inventing the name 'gas', which he says he derived from 'chaos'. He thought a gas could not be kept in a vessel, for he corked up limestone and acid in a bottle, which soon burst. Van Helmont mentions nitric oxide gas from metals and nitric acid, and an inflammable gas which he calls *gas pingue*. He made quantitative experiments, and showed that when a metal is dissolved in an acid it can be recovered again with its original weight from the solution. He recognized that digestion is effected by some kind of ferment in the stomach. Van Helmont believed in a universal solvent, called *alkahest*, but does not explain how he was able to keep it. Boyle had a high opinion of van Helmont, who, in spite of some credulity, was a highly original thinker and a clever experimenter.

Chemistry proper appears about his time, and its first text-book is the "Alchemia" of Libavius (1597), which included the teachings of Paracelsus, but criticized his absurdities. It is a well-arranged work. Libavius describes zinc, and discovered anhydrous stannic chloride, afterwards known as "Libavius's fuming liquor".

Glauber (1604–70), another German, was a skilled practical chemist. In his book, "New Philosophical Furnaces" (1646–49), he describes the preparation of spirit of salt (hydrochloric acid), and by dissolving metals in it he prepared many new salts, the metal chlorides. Sodium sulphate is still known as 'Glauber's salt'. He made malt extract, and another of his experiments is the 'chemical garden', made by putting bits of metallic salts in a solution of water glass.

A popular text-book was the "Cours de Chymie" of a Frenchman, Lemery, first published in 1675, which went through a large number of editions and translations. It divides bodies into animal, vegetable, and mineral, and uses the corpuscular theory, explaining properties by the different forms of the particles, acids having sharp-pointed particles which prick the tongue, and tear apart and dissolve metals.

Tachenius, a German who worked for a time in a soap factory in Venice, in his "Hippocrates Chimicus" (1666) defines a salt as composed of an acid and a base. Kunckel, an alchemist in the service of Frederick William of Brandenburg, the Grosse Kürfürst, in Berlin, independently discovered phosphorus and gold ruby glass. His "Laboratorium Chymicum" was published in 1716, after his death in 1703. He admits that he failed to transmute metals into gold.

Chemistry assumed a new dignity, and became scientific, by the work of Robert Boyle (1627–91), who insisted that it was worthy of independent study, and was not merely the handmaid of alchemy or medicine. In his "Sceptical Chymist" (1661) he shows that the true elements are not the four elements, or the three alchemical principles, since none of these can be extracted from bodies. He believed in the atomic (or as he calls it, the corpuscular) theory, and suggested that different bodies result from the different motions and mutual actions of the small particles of matter. The famous Boyle's law was stated in 1662, and many experiments were made with an air pump, with which it was shown that combustion would not proceed in a vacuum, unless the combustible were mixed with nitre or saltpetre, which led him to suspect that this salt contains something also present in the air. This theory was elaborated by Hooke and Mayow, both of whom worked with Boyle in Oxford.

John Mayow (1641–79), born in Cornwall, was later a physician in Bath and London. His "Tractatus Quinque" (1674) describes fundamental experiments on combustion and respiration, both of which he says are maintained by a part of the atmosphere present in a fixed state in nitre, and which he called the 'nitro-aerial spirit'. He showed that antimony gains in weight when calcined in air, and supposed that this is due to absorption of nitro-aerial spirit. The increase in weight of tin and lead on calcination in air had been described by a French physician, Jean Rey, in 1630, who suggested, not very clearly, that air is fixed in the process.

The study of combustion and calcination by Boyle and Mayow, if pursued, would have led to a correct theory, but it was interrupted by the appearance of a theory which long retarded the progress of chemistry. This was the famous phlogiston theory of Becher and Stahl.

Becher, born in 1635 at Speyer in Germany, was for a time in England, where he is said, on not very good authority, to have died in 1682. In his book "Physicæ Subterraneæ" (1669), he gives as constituents of bodies, air, water, and three earths, one of which is inflammable (*terra pinguis*), the second mercurial, and the third fusible or vitreous. These earths correspond with sulphur, mercury, and salt.

Stahl, born in Anspach in 1660, studied medicine at Jena, where he lectured on chemistry; he became in 1694 professor of medicine at Halle, but left in 1716 to become physician to the King of Prussia in Berlin, where he died in 1734. His first statement of the phlogiston theory was in his "Zymotechnia Fundamentalis" (1697). It was extended in his edition of Becher's "Physica Subterranea" in 1703, and in his "Fundamenta Chymiæ" (two editions in 1723 and 1746–47). All combustible bodies and metals were supposed to contain a common and identical principle, to which Stahl gave the name *phlogiston*. This was similar to Becher's *terra pinguis*, and could be transferred from one body to another. A metal on calcination loses phlogiston and becomes a calx (an oxide), which when heated with oil or charcoal takes up phlogiston again and reverts to metal. A metal is thus regarded as a compound of its calx (an element) and phlogiston. The known fact that the calx weighs more than the metal was a difficulty, explained (when it was thought worthy of consideration at all!) in various unsatisfactory ways, one being that phlogiston had a negative weight. The phlogiston theory was generally accepted during the eighteenth century, but Boerhaave, professor at Leyden, does not mention it in his famous text-book, "Elementa Chemiæ" (1732), each genuine copy of which is signed by the author.

It was only after the discovery of oxygen that a correct theory of combustion could be formulated. Oxygen was discovered independently by Scheele in Sweden about 1772 and by Priestley in England in 1774, but both continued to believe in the phlogiston theory. The correct explanation of their experiments was first given by Lavoisier.

Between the enunciation of the phlogiston theory by Stahl, and its overthrow by Lavoisier, many distinguished chemists had made important discoveries: Black, Priestley, and Cavendish in Britain; Bergman and Scheele in Sweden; Macquer and Baumé in France; and Marggraf (the discoverer of beet sugar) in Germany. Cavendish and Priestley made great progress in the discovery of gases, the latter using the familiar pneumatic trough for collecting them in jars over water. Soluble gases were collected over mercury.

Lavoisier overthrew the phlogiston theory, and put the new theory in its place, largely by the use of the balance, and the earlier work of Black was also founded on quantitative experiments; Lavoisier, although not always giving enough credit to his predecessors, emphasized the importance of Black's work, which he says he took as a model for his own.

Joseph Black, born in 1728, in Bordeaux (where his parents had emigrated to set up a wine business), studied medicine and chemistry in the University of Glasgow, where in 1756 he succeeded Cullen as professor of chemistry. In 1754 he became M.D. of Edinburgh with a dissertation on magnesia, published in an enlarged form in 1756. In 1766 he succeeded Cullen at Edinburgh as professor of chemistry, where he remained until his death in 1799. Black's lectures attracted large audiences and were illustrated by excellent experiments. The lectures were published in two volumes in 1803 by his pupil Robison, and were also translated into German. Before this, many manuscript copies were in circulation, and several still survive. One copy, interesting on account of its early date (1767–68), was made by Thomas Cochrane, and is illustrated by some clever drawings of Black.

In Black's time, two fixed alkalis, potash and soda, and a volatile alkali, ammonia, were known both in so-called mild forms, and in the caustic forms obtained from these by boiling with water and slaked lime, made from quicklime and water. The quicklime was changed into limestone or chalk, and the alkali became caustic. The phlogistic chemists explained this as due to the passage of a fiery or caustic principle (which the limestone had taken up on burning) from the quicklime into the mild alkali, which became caustic. Thus, quicklime was a compound of limestone and the fiery principle (called *acidum pingue* by Meyer), and caustic alkali a compound of mild alkali and acidum pingue. Black showed that limestone when burnt to quicklime, and a mild alkali when it becomes caustic, both lose weight. On burning limestone, a gas escapes. This is what Van Helmont called *gas sylvestre*; Black called it 'fixed air'; it is carbon dioxide. Limestone is thus a compound of quicklime and fixed air, and mild alkali a compound of caustic alkali and fixed air. On boiling mild alkali with quicklime, the latter takes fixed air from the alkali, leaving it caustic, and is itself converted into limestone. All this Black proved by exact weighings. Black knew that fixed air is evolved from the lungs on expiration.

Scheele and Priestley obtained oxygen in several ways, notably by heating red oxide of mercury, or red precipitate. They found it to support combustion much better than common air; and Scheele that the whole of the oxygen gas is used up in the process, whereas common air left four-fifths of its volume of a gas which did not support combustion or respiration.

Antoine Lavoisier, born in France in 1734, was carefully educated and, having ample means, devoted himself to science. His most important work was begun in 1770, and continued until his death on the guillotine in 1794, when he suffered the penalty of a *Fermier général*, or tax collector, although he had discharged this office honourably and honestly, as well as doing much important work in the service of the State.

Lavoisier learned of the isolation of oxygen in 1774 from Priestley himself in Paris, and soon saw that it was a part of the air concerned with combustion and calcination, which resulted from a combination of oxygen with the combustible or metal, and not from a loss of phlogiston. In the course of further work, he confirmed this conclusion, which he stated fully in 1783.

Since non-metals such as sulphur, phosphorus and carbon, on combustion in oxygen, form acids, Lavoisier proposed the name *principe oxigine*, from the Greek meaning 'producer of acids'. He drew up a list of elements, these being substances which, so far, had not been divided by chemical processes into any simpler bodies, and in 1789 he published his famous text-book, "Traité Élémentaire de Chimie". In this he describes an experiment in which mercury is heated in a confined volume of air, when it slowly takes up oxygen to form some red oxide, and the air contracts to a limiting volume. On heating the red oxide, oxygen is evolved, in volume equal to the contraction suffered by the air. Lavoisier also showed that oxygen is absorbed in the blood in respiration, as Mayow suspected, and carbon dioxide evolved, the oxidation of material containing carbon being the source of animal heat. With Lavoisier, chemistry entered its modern phase. Only one further step remained, and this was taken by John Dalton by the introduction of the atomic theory.

The atomic theory goes back to the old Greek philosopher Demokritos, about 450 B.C., was revived in the Epicurean philosophy, and made into a poem by Lucretius. It was never lost sight of, but was notably revived by Gassend early in the seventeenth century. Newton made extensive use of it, and an early application to chemistry was by William Higgins in 1789, who recognized that combination occurs in multiple proportions by successive addition of 1, 2, 3, etc., particles of one element, say oxygen, to one particle of another, say nitrogen. Higgins's work was appreciatively mentioned by Davy. Richter, in Germany, from 1791, had introduced the idea of combining weights.

John Dalton was born in 1766 in Cumberland, his parents being Quakers, to which society he himself belonged. His circumstances were modest, and he supported himself all his life by teaching, being appointed professor of mathematics and natural philosophy in New College, Manchester, in 1793. The College later moved to York, but Dalton remained in Manchester, earning his living as a private tutor, until his death in 1844. One of his pupils was the great physicist Joule. Dalton's main characteristics were plainness, modesty, and perseverance, united to genius.

Dalton's atomic theory arose from the influence of Newton, whose writings he had carefully studied. He took from Newton the theory that a gas exerts a pressure because of repulsive forces between its particles, the latter being at rest. The kinetic theory, postulating that pressure is due to bombardment by moving particles, although proposed by Bernoulli in 1738, had dropped out of sight. Dalton supposed that the repulsion was due to atmospheres of heat, which Lavoisier supposed was an imponderable material element called 'caloric', surrounding the material atoms.

In 1801–2, Dalton read several important papers to the Manchester Literary and Philosophical Society, describing the law of partial pressures, the solubilities of mixed gases, and the vapour pressures of liquids; and in 1803 he read a paper on "The Proportions of the Several Gases or Elastic Fluids Constituting the Atmosphere", to which, when it was first printed in 1805, the first table of atomic weights had, in the interval, been added. He was in possession of this theory before 1804, since in August of that year he explained it to Thomas Thomson, who published an account of it in 1807. The theory, and atomic symbols, are used in Dalton's notebooks of 1803.

Dalton seems to have been led to the atomic theory on physical grounds in attempts to explain the properties of mixed gases. He calculated the relative weights of the atoms, taking the weight of the lightest atom, that of hydrogen, as 1. In order to do this, he made assumptions about the numbers of atoms combining; for example, he supposed that water contains one atom each of hydrogen and oxygen, whereas we now know that it contains two of hydrogen and one of oxygen. The theory explained the facts of chemical combination, including the law of multiple proportions, and the results found by Richter. Dalton's theory was first made known by Thomas Thomson, professor at Glasgow, who gave an account of it in his "System of Chemistry" in 1807. The first volume of Dalton's "New System of Chemical Philosophy" appeared in 1808. Dalton used curious symbols, that for hydrogen being ⊙, like the Bohr atom; the modern chemical symbols were introduced by Berzelius in 1813.

Dalton's atomic theory is the great guiding principle of modern chemistry. It has suffered slight modification, since all the atoms of a given element are not of identical weight, as Dalton thought; and also, as Newton suspected, it has proved possible to divide atoms experimentally into simpler parts, so that the atoms are formed of a small number of primary particles, and the artificial transmutation of elements is now a fact. If anything, however, the atoms have become more real than they were even for Dalton, who saw them clearly in the eye of the mind.

With Dalton, chemistry had become a modern science, and a history of alchemy and early chemistry ends; he brought the science to the beginning of the road it has followed ever since.

EARTH MOVEMENT RESULTING FROM AN ATOMIC BOMB EXPLOSION

IN 1904, Horace Lamb published[1] solutions of elastic wave equations, and predicted the wave pattern at a distant point from waves generated by an impulsive force applied vertically at the earth's surface. From this work he suggested that the general to-and-fro movement characteristic of a seismogram might be due either to a succession of primitive shocks or to instrumental imperfections.

On Monday, July 16, 1945, Lamb's conditions of a single initial vertical ground impulse were met experimentally for the first time at the test of the atomic bomb in Jornada del Muerto Valley, New Mexico. On that occasion the source of the earth tremors was a simple single instantaneous vertical impact on the ground produced by the explosion of an atomic bomb 100 ft. above the surface. There was no succession of primitive shocks to explain unpredicted oscillations, and the three-component Leet seismograph orientated in three mutually perpendicular directions, (*a*) horizontally from point of observation to point of explosion, (*b*) horizontally at right angles to (*a*), and (*c*) vertical, was magnetically damped about 0·7 critical, so there was no question of instrumental self-oscillation. The magnitude of the ground vibrations has not yet been made public, but the qualitative analysis of the records has just been published by L. Don Leet[2].

The seismograms showed continuous oscillation. The first waves to arrive were P_2, refracted compressional waves, on the longitudinal and vertical seismograms, followed by S_2, refracted shear waves, on the transverse seismogram. After these came the P_1, direct compressional waves on the longitudinal and vertical components. Coupled waves on all components succeeded these, and were followed by H, hydrodynamic waves, on the longitudinal and vertical components. Surface shear waves arrived at the point of observation shortly afterwards and were recorded on the transverse seismogram. The latter ones of these were accompanied by horizontally polarized surface compressional waves on the longitudinal seismogram. The remaining part of the seismograms had Rayleigh waves on the longitudinal and vertical components and surface shear waves on the transverse seismogram.

P_2 was the standard bodily compressional wave. Leet states that from its angle of emergence as well as its velocity, the wave must have been refracted through material capable of transmitting waves of higher velocity than the surface layer could. P_1 travelled through the earth's surface layer. S_2 was an independent transverse wave assumed to have been a refracted body wave because of its velocity and period. Leet noted transverse motion from the very beginning of the record. C has been called the coupled wave. It was not predicted by standard elasticity theory, but was observed by Leet in 1939[3]. The diagnostic characteristic of this wave is that a particle in its path moves along the diagonal of a rectangular frame facing in the longitudinal direction. This results in simultaneous maxima and minima on all three components of the seismograph registrations. A novel feature of this wave on the atomic bomb record was that it was twinned. There was a C wave of period 0·4 sec. arriving at the same time and co-existing with one of period about 1·0 sec. The motion of a particle was left up push – right down pull. Q, the surface shear wave, arrived on the transverse component just as C was dying out. H, the hydrodynamic wave, was new to seismology. The wave caused a particle in its path to move in a longitudinal–vertical plane, clearly independent of motion on the transverse component at the same time. Leet states that the unique and significant thing about the H motion is that it is the opposite of that of the Rayleigh wave, and the particle at the top of its inclined elliptical orbit moves forward as for a wave on water. He is of the opinion that it seems reasonable to attribute the existence of the H wave to special properties of the material at the surface of the Jornada del Muerto Valley, namely, alluvial sands and gravels. A similar wave has been observed by Leet from a small dynamite shot in an area having a surface layer of sand 55 ft. thick underlain by clay 165 ft. thick. In both cases the horizontal component of H dominated the vertical, and the major axis of the elliptical path was inclined at an acute angle to the horizontal plane. R, the Rayleigh wave, caused particle movement in an elliptic orbit with the minor axis longitudinal and the major axis vertical. At the top of its elliptical orbit, the particle moved towards the source. The vertical component was larger relative to the horizontal than for H, but not in the classical ratio of vertical : horizontal = 1·5 : 1. The coupled wave carried an appreciable portion of the energy in the ground waves, and the hydrodynamic wave produced the greatest displacements on the record.

Leet's paper represents an important advance towards the solution of the seismological problem of establishing observationally the types of waves which can be supported by earth materials in their natural position.

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[1] *Phil. Trans. Roy. Soc.*, A, **203**, 1 (1904).

[2] Leet, L. Don, "Earth Motion from the Atomic Bomb Test"; *American Scientist*, **34**, No. 2 (1946).

[3] Leet, L. Don, *Bull. Seis. Soc. Amer.*, **29**, 487 (1939).

RELATIONSHIP BETWEEN STRUCTURE AND ACTION IN DRUGS WITH CURARIFORM ACTIONS

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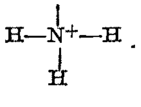
ING and Wright[1,2], in two comprehensive papers, presented the results of the measurement of the curariform activity of an extensive series of onium salts. Later, Ing[3] reviewed the literature up to 1936. Since that time much interesting work on the subject has appeared, the three papers by Raventos[4], Clark and Raventos[5] and Raventos[6] being of special interest from the theoretical point of view.

We can start with a consideration of the differences between the structure of the ammonium ion according to the classical theory of valency and the structure of the same ion according to quantum mechanics. Classical theory assigned the structure



$$\begin{array}{c} \mathrm{H} \\ | \\ \mathrm{H{-}N^{+}{-}H} \\ | \\ \mathrm{H} \end{array}$$

to the ammonium ion, and tacitly assumed the charge to be localized to the nitrogen atom. The development of quantum mechanics has, however, led to a reconsideration of this structure, and Pauling[7] has pointed out that resonance between ionic and covalent bonds of the type $A{-}B \rightleftarrows A^{+}\,B^{-}$ will result in a distribution of the positive charge in the ammonium ion. He points out that sixteen structures have to be considered, one completely covalent structure

$\begin{array}{ccc} & \mathrm{H} & \\ & \cdot\cdot\,{}^{+} & \\ \mathrm{H}: & \mathrm{N} & :\mathrm{H}, \\ & \cdot\cdot & \\ & \mathrm{H} & \end{array}$ four such as $\begin{array}{ccc} & \mathrm{H} & \\ & \cdot\cdot & \\ \mathrm{H}: & \mathrm{N} & :\mathrm{H}^{+}, \\ & \cdot\cdot & \\ & \mathrm{H} & \end{array}$ six such as $\begin{array}{ccc} & \mathrm{H}^{+}_{-} & \\ & \cdot\cdot & \\ \mathrm{H}: & \mathrm{N} & :\mathrm{H}^{+}, \\ & \cdot\cdot & \\ & \mathrm{H} & \end{array}$ four such as $\begin{array}{ccc} & \mathrm{H}^{+}_{=} & \\ & \cdot\cdot & \\ \mathrm{H}: & \mathrm{N} & :\mathrm{H}^{+}, \\ & \cdot\cdot & \\ & \mathrm{H}^{+} & \end{array}$ and one completely ionic structure $\begin{array}{ccc} & \mathrm{H}^{+}_{\equiv} & \\ & \cdot\cdot & \\ \mathrm{H}^{+}: & \mathrm{N} & :\mathrm{H}^{+}. \\ & \cdot\cdot & \\ & \mathrm{H}^{+} & \end{array}$ He concludes that the unit ionic charge is distributed approximately equally among the five atoms, the nitrogen atom, therefore, being left with only + 0·2 charge.

Further, according to Pauling's view, the ionic contribution to the bond $[R_3X—R]^+$ in an onium ion (and hence the charge-distributing effect) will depend on the relative electro-negativity of the group *R* and the atom *X* and, other things being equal, on the ionic radius of both *R* and *X*. From these considerations alone it is difficult to avoid the conclusion that curariform action, a property of onium ions in a very widely different series of compounds, will be affected by the intra-ionic positive charge distribution. In attempting to apply these ideas, we will consider the compounds of the ammonium series first and then inquire into the effect of replacing the nitrogen atom by sulphur, phosphorus and arsenic, and finally try to assess the influence of complex molecular structure on the distribution of the central positive charge.

We can attempt to determine the influence of the group *R* in $[R_4\mathrm{N}]^+$ in two different ways. First, a comparison of the dissociation constants of acids of the series *R*COOH should give us an indication of the order of relative electro-negativity of *R*. In comparing the series *R*COOH and $[R_4\mathrm{N}]^+$, it is clear that the relative effects of the series on the charge on the nitrogen atom will be magnified because four *R* groups act on it as compared with one in *R*COOH. Secondly, consideration of the dissociation constants of the corresponding primary, secondary and tertiary amines should be of interest. Here the dissociation constants are a measure of the reactions

$$[R\mathrm{H_2N—H}]^+ \rightleftharpoons R\mathrm{H_2N} + \mathrm{H}^+$$
$$[R_2\mathrm{HN—H}]^+ \rightleftharpoons R_2\mathrm{HN} + \mathrm{H}^+$$
$$[R_3\mathrm{N—H}]^+ \rightleftharpoons R_3\mathrm{N} + \mathrm{H}^+$$

and hence their magnitude will be influenced by the charge on the central nitrogen atom.

TABLE 1

Group *R*	Curariform activity of R_4NI	$K_A \times 10^5$ of *R*—COOH	$K_B \times 10^5$ of R_3NH(OH)	$K_B \times 10^5$ of $R_2\mathrm{NH_2}$(OH)	$K_B \times 10^5$ of $R\mathrm{NH_3}$(OH)
$\mathrm{CH_3}^-$	5·8	1·753	5·45	52	43·8
$\mathrm{C_2H_5}^-$	No action	1·338	64	126	56
$\mathrm{C_3H_7}^-$	11·5	1·542	55	102	47
$\mathrm{C_4H_9}^-$	6·25	1·380			

Curariform activity[3] is expressed in minutes required to paralyse frog sartorius.

TABLE 2

Onium ion	Curariform activity of onium ion	Corresponding single bond with H	Dipole moment × 10^{18} of bonds in previous column
$[(\mathrm{CH_3})_4\mathrm{N}]^+$	5·8	N—H	1·31
$[(\mathrm{CH_3})_3\mathrm{S}]^+$	16	S—H	0·68
$[(\mathrm{CH_3})_4\mathrm{P}]^+$	17	P—H	0·36
$[(\mathrm{CH_3})_4\mathrm{As}]^+$	No action	H—As	0·10

Curariform activity is expressed as in Table 1. The dipole moment for As—H is in the opposite direction to the others, hence it is shown as H—As. The dipole moment values are from Pauling[7].

These lines of approach are limited by the lack of reliable values for the dissociation constants required.

In each series in Table 1 we see that when *R* is $\mathrm{C_2H_5}^-$ the bases are strongest and the acid weakest. This anomaly is also seen in much more marked form in the curariform activity column. If we assume that the $\mathrm{C_2H_5}^-$ group is not so electron-attracting as the rest, we can conclude that when the positive charge on the nitrogen atom in simple onium salts falls below a certain level, the compound loses its pharmacological activity very rapidly.

In the case of the symmetrical onium ions derived from nitrogen, sulphur, phosphorus and arsenic, we can obtain a qualitative idea of the influence of the central atom on the partial ionic character of the *X*—$\mathrm{CH_3}$ bond from the dipole moments of the corresponding *X*—H bonds, because change in *X* from nitrogen to sulphur to phosphorus to arsenic should influence both $\mathrm{CH_3}^-$ and H^- bonds in the same sense. But since the central charge on the onium atom depends on the amount of partial ionic character in the *X*—$\mathrm{CH_3}$ bond, the central charge should vary with the dipole moment in the correct direction. That it does (Table 2) is clear except in the case of arsenic, where there is a sudden loss in curariform activity. This sudden failure is like that which occurs in $[(\mathrm{C_2H_5})_4\mathrm{N}]^+$. In N—H and S—H the relative electro-negativity of the atoms in the bonds is such as to move the electrons towards the hydrogen atoms, nitrogen having more effect than sulphur, and hence to increase the positive charge on the central atom. In P—H the relative electro-negativity is zero, and in As—H it acts to decrease the charge on the central atom.

It seems clear, therefore, that in any onium ion of the type $[R_n—X]^+$ the charge distribution in the ion and hence that left on *X* will depend on the relative electro-negativity of *R* and *X*; and it appears that curariform activity requires that the central positive charge should not fall below a certain level.

It has been known to chemists for a long time that conjugated systems have a charge-distributing effect. We would therefore expect, other things being equal, to find less curariform activity from onium atoms attached to unsaturated systems, as opposed to the corresponding saturated compound. In this connexion it is noteworthy that at a concentration of 2 millimols per litre (Ing and Wright[2]) both dimethyltetrahydroquinolinium iodide and methyl ethyltetrahydroquinolinium iodide are more active than the corresponding unsaturated compounds methyl quinolinium iodide and ethyl quinolinium iodide.

The above theory as it stands does not explain why, when nitrogen forms part of a ring system, replacement of methyl by ethyl in the quaternary salt leads to an increase in curariform action if the ring is aromatic and to a decrease if the ring be saturated. It is possible, however, that the quasi triple bond $H_3\equiv C$— in methyl may hyperconjugate[8] if the ring be aromatic; this would cause an electron shift towards the ring and hence a decrease in the charge on the N atom which could not occur to such an extent if $C_2H_5^-$ were present instead of CH_3^-.

This theory does not explain why tetraethyl arsonium is more active than tetramethyl arsonium; but as Malone[9] has pointed out, the relationship between relative electro-negativity and bond dipole moment between arsenic and several other atoms is anomalous; and in the absence of further physicochemical information on the bond in the trimethyl and triethyl arsonium iodides, it is difficult to see how these considerations can connect the physical and pharmacological anomalies in these two compounds.

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SCIENTIFIC EXPEDITION TO THE ANTARCTIC WHALING GROUNDS, 1946–47

By DR. R. A. M. CASE

A BRITISH scientific expedition is on its way to the Antarctic whaling grounds on board the new whale-factory ship *Balaena*, which has been equipped with a laboratory for biochemical and physiological work with specially designed apparatus for use at sea. The expedition has been organised by the Department of Scientific and Industrial Research on the initiative of Dr. Franklin Kidd, superintendent of the Low Temperature Research Station, Cambridge. It has as its main aim a study of the fuller utilization of the large potential supplies of whale meat protein for human food in view of the present world shortage of high-grade protein. Its secondary aim is the general one of advancing knowledge of the physiology and biochemistry of the whale. The expedition has been made possible by the collaboration of Messrs. United Whalers Ltd., who generously provided a laboratory and facilities for the investigations on board their new ship.

A preliminary investigation in 1939–40 by the Department under the leadership of Lieut.-Commander Marr of "Discovery" Investigations confirmed in the first place what whaling personnel have always stated, namely, that a large proportion of meat from the carcase is scarcely distinguishable from beef, and in the second place showed that there are wide variations in the quality of the meat from different carcases and from different parts of the same carcase. The meat shows a great diversity of colour, ranging from a pale veal tint through many shades of red to a curious deep red black, and this may possibly be correlated with the age of the whale[1].

The lean meat from the back muscles alone, the longissimus dorsi and psoas, on the basis of the total British and Norwegian pre-war catches, was estimated to amount to more than half a million tons, which is equivalent to about half the total amount of meat imported into Great Britain before the War.

The expedition will carry out palatability tests on a large number of whales and make observations on various factors which may have an influence on quality, such as: mode of death; whether accompanied by exhaustion; with or without bleeding; the time between slaughter and cutting up; and the subsequent freezing and storage history. Biochemical analyses will be carried out on board the whaling vessel on selected representative samples, and control samples frozen at various temperatures will be brought back for re-assessment and more complete analyses at the Low Temperature Research Station.

The above data, it is hoped, will be correlated with the biological data on the whole catch of the factory ship, collected by an inspector of the Ministry of Agriculture and Fisheries and by a biologist working for the "Discovery" Committee.

The diversity of colour will be studied, attention being paid to various fractions of the muscle pigment such as myoglobin, hæmoglobin and a third yellow protein fluorescing in ultra-violet light which has not yet been fully investigated, but which I have recently found in considerable quantities in frozen whale muscle by extraction with $M/15$ phosphate buffer at a pH of 6·5.

The opportunity will be taken to study the physiology and especially the under-water physiology of the whale and of collecting specimens of interest in other branches of science. The physiological work has the support of the Royal Naval Physiological Laboratory and the Royal Naval Personnel Research Committee. The interest of the former has led to the loan to the expedition of special equipment, such as, for example, recording thermographs of the harpoon type, for obtaining carcase temperatures, which will be of great value in collecting data required in fulfilment of the main objective. An attempt to obtain samples of blood and tissues from the whale carcase after it surfaces from its final dive will be made by a scientific man working in a self-contained oxygen swim-suit ('frog man suit'). In this way it is hoped to obtain some information about the gaseous equilibrium of a recently surfaced beast. A proper understanding of the diving mechanisms of whales might be used to throw more light on some problems of human divers. Members of the team underwent special training at Fort Blockhouse to enable them to carry out this project, and the Royal Navy has placed diving-gear at their disposal.

The under-water physiology of the whale is by no means unconnected with the qualities of whale meat as a food, because the character or composition of the muscles of the whale are adapted in several striking respects to the requirements of its submarine existence. There are indications from work carried out on material from the previous expedition that, as an indirect consequence of this adaptation, the proteins of whale meat are of exceptional value for growth by comparison with the meat proteins of land animals.

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NEWS and VIEWS

Mathematics at Sheffield: Prof. A. G. Walker

Dr. Arthur Geoffrey Walker has been appointed to the chair of mathematics in the University of Sheffield, in succession to the late Prof. P. J. Daniell. Dr. Walker has been a member of the Department of Pure Mathematics at Liverpool for the past ten years. He is thirty-seven years old and was educated at Watford Grammar School and at Balliol College, Oxford. On taking his degree in 1931, he went to Edinburgh and commenced research under Prof. (now Sir) Edmund Whittaker. This was a time of exceptional activity at Edinburgh. Prof. Whittaker was mainly interested in relativity and differential geometry, and his staff, which in the years 1927–32 included E. T. Copson, J. M. Whittaker, J. G. Semple, H. S. Ruse, W. H. McCrea and A. Oppenheim, all of whom have gone on to professorial chairs, for the most part followed his lead. To Walker, who had gained distinction in differential geometry in the Final Honours School at Oxford, the subject of Prof. Whittaker's lectures was particularly congenial, and he wrote several papers, the first of a long series on differential geometry, relativity and cosmology. In 1933 he returned to Oxford to take up a Harmsworth Research Scholarship at Merton College, to which he had been elected in the previous year. He worked with Prof. E. A. Milne on kinematical relativity, then at the beginning of its stimulating and controversial career. This subject has continued to engage Dr. Walker's attention ever since. He is a supporter of Milne's general point of view, but has developed a more general theory, which seems capable of accounting both for cosmological effects and for phenomena due to intense local gravitational fields such as that of the sun. Certain functional equations present themselves in this work, and he has investigated them from the point of view of pure mathematics in collaboration with his Liverpool colleagues F. W. Bradley, now professor of mathematics at the University of Alexandria, and Miss Joyce Batty.

Fuel Technology at Sheffield: Prof. R. J. Sarjant, O.B.E.

The chair of fuel technology in the University of Sheffield has been vacant since the death of Prof. R. V. Wheeler in 1938, and the appointment of Dr. R. J. Sarjant to it assumes added importance in view of the national coal situation and the industrial area served by the University. Dr. Sarjant, who is chairman of the Yorkshire Section of the Institute of Fuel, has wide academic knowledge and industrial experience; trained under the late Prof. W. A. Bone at the Imperial College of Science and Technology, London, where he worked upon the constitution of coal, he was appointed in 1918 as fuel officer to the Research Department of Messrs. Hadfields, Ltd., there undertaking tasks pioneering in character. He published with Sir Robert Hadfield a number of papers on the uses of solid, liquid and gaseous fuels, gas producer practice, alloy steels for furnaces and chemical engineering, and gave the first course of lectures on furnace heating at the University of Sheffield in 1924. His later investigations dealt with: special aspects of the design of open-hearth, re-heating and heat-treatment furnaces; refractories and moulding sands; and various metallurgical, physical and radiological fields. In 1937 he was appointed a local director of Messrs. Hadfields, Ltd., and head of its Research Department; and during the War he rendered valuable service on a number of committees, particularly the Fuel Efficiency Committee of the Ministry of Fuel and Power, being chairman of its Education Sub-Committee which produced a notable war-time publication, "The Efficient Use of Fuel". He was the author of "Furnace Heating" (1925), and the section on fuel economy in industrial furnaces in "Coal: Its Constitution and Uses" (1936) by Bone and Himus. An account of his most recent research in collaboration with Prof. D. R. Hartree on the variable heat flow in solids has now appeared in the *Philosophical Transactions of the Royal Society*. Prof. Sarjant's appointment at the University of Sheffield will be widely welcomed.

Bicentenary of Johann Elert Bode

January 19 is the bicentenary of the birth of Johann Elert Bode, who at one time was the foremost astronomer in Germany. The son of a schoolmaster at Hamburg, from boyhood Bode was given to astronomical calculations and observations, and at the age of twenty-one published an elementary treatise which became very popular. He next published an essay on the transit of Venus of 1769. In 1772 Frederick II of Prussia called him to Berlin and made him astronomer to the Academy of Sciences, and the remainder of his life was spent in the Prussian capital. He commenced in 1774 the periodical *Astronomische Jahrbücher*, and in 1778 re-stated the law of planetary distance known by his name, which, however, had been stated previously by Titius and Wolf. It was through Bode that the name Uranus was given to the planet discovered by his fellow-countryman Herschel. His "Uranographia", published in 1801, gave observations of 17,240 stars. He made no important discoveries of astronomical objects, but by his writings and activities did much to diffuse a knowledge of astronomy in a country where for a time scientific studies had languished through the disasters of war. Bode died in Berlin on November 23, 1826, aged seventy-nine.

Cave Art at Lascaux

The discovery during the War of prehistoric paintings in the Lascaux Caves near Montignac in south-western France is of the highest interest. A large pine tree had blown down, and some French boys wandering with their dog in the vicinity found under its roots the entrance to a hitherto unknown cave. On the walls were innumerable paintings, many of them of large size, which were soon recognized as being palæolithic. Lascaux, though some distance from the well-known cave sites near Les Eyzies, is after all not so far away from them, and local folk knew by hearsay all about such places as Font de Gaume, Combarelles, etc. But the new paintings (there are also some engravings), while similar in style to some of the paintings at these other sites, are for the most part different. Indeed, the importance of the new discovery is that it vastly increases our knowledge of the earlier styles, of which elsewhere we have so far only known a little. The Lascaux pictures are mainly of Aurignacian age, antedating the wonderful polychromes found at Altamira in northern Spain and Font de Gaume in the Dordogne, and throw a new light on the evolution of this Phase I of the cave art which is now likely to become a great deal clearer. Many of the figures are very large and include drawings of bulls, horses, stags, bison and rhinoceros.

In one or two instances the animals are painted with their tongues out—reminding one of certain paintings of the eastern Spanish rock-shelter art, as also does the way in which some of the Lascaux animal horns are depicted. These two circumstances back up the contention that a part at any rate of the eastern Spanish art is palæolithic in date. Altamira is the site where the finest Magdalenian paintings have been preserved. Lascaux can claim the same title in respect to the earlier Aurignacian art.

The All-Russian Mineralogical Society

The Russian Mineralogical Society is celebrating its hundred and thirtieth anniversary during January 19–25, 1947, in Leningrad. This anniversary is being specially marked, because it was not possible to celebrate appropriately either the centenary or the hundred and twenty-fifth anniversary, since these occurred in 1917 and 1942 respectively. The Society is the oldest mineralogical society in the world—the Mineralogical Society of Great Britain and Ireland was founded in 1876 and the Société Minéralogique de France in 1878. Before the founding of the Geological Committee in 1881 in Russia, the Mineralogical Society was almost the only institution conducting regular geological and mineralogical exploration in that country. It thus became a centre for the collection of information concerning discoveries in little-known Russian regions. Among its most active members have been such brilliant scientific men as N. I. Koksharov, E. E. Chernyshev, E. E. Fedorov and A. Karpinsky. The present chairman of the Council is Academician S. S. Smirnov.

The Society has substantially influenced the development of the science of mineralogy through its publications, which began in 1830; they were issued at irregular intervals under various titles until 1866, when publication commenced of the periodical *Notes of the All-Russian Mineralogical Society* (*Zapiski Vserossiiskogo Mineralogicheskogo Obshchestva*). This was the first specialized mineralogical journal in the world; the *Mineralogical Magazine* commenced publication in 1877, *Bulletin de la Société Minéralogique de France* in 1878 and the *American Mineralogist* in 1916. Later Russian publications were the Bulletins and the Memoirs of the Geological Committee published departmentally (1883) and the Transactions of the Geological and Mineralogical Museum of the Academy of Sciences (1906). The discoveries of Russian mineralogists embodied in the *Notes* form an essential contribution to the world science of mineralogy. They include such classic memoirs as those by N. I. Koksharov and V. P. Yeremeyev reporting the measurements of minerals, the announcement by A. Gadoin of the discovery of 32 classes of symmetry, E. Federov's work on the discovery of the 230 space groups and many other important papers. The chief tasks of the Society are the exploration of the mineral wealth and soils of the U.S.S.R.; the spreading of mineralogical, geological and palæontological information within the U.S.S.R.; the establishment of closer contact among Russian men of science working in these fields and facilitating their relations with scientific institutions abroad.

A Monument to Darwin in Uruguay

In *Nature* of July 24, 1937, p. 138, it was recorded that Prof. Karl Walther, of Montevideo, had erected a stone on the Cerro de los Claveles to commemorate Darwin's visit to the locality in 1833. The project matured during the years of war, and Walther's original suggestion has now resulted in the erection of a monolith to the memory of Darwin on the summit of the Cerro. The Cerro was Darwin's 'farthest north' in Uruguay, to which he travelled on horseback from Montevideo. Nowadays it is easier to approach it by rail from Montevideo to Mercedes, the capital of the Department of Soriano, and thence by road to the Cerro 50 km. or more to the north-east on the high southern bank of the Río Negro at its confluence with the Arroyo Perico Flaco. The nearest village, formerly Saca Chispas, about 5 km. to the south of the Cerro, has been renamed Darwin in honour of the great master. It is a source of much gratification to note how, after more than a hundred years, Darwin's name and fame are still being honoured and acclaimed in Uruguay.

Zoological Society of London: Anatomical Research Fellowship

The Council of the Zoological Society of London has decided to re-establish a research fellowship in order to encourage investigations on the comparative anatomy of the animals brought to its prosectorium. The appointment offers unrivalled opportunities for work in this subject, in view of the wealth of material available, amounting during the course of an average year to approximately a thousand mammals, birds, reptiles and amphibians. Some of these animals belong to species likely to become extinct in the near future, and it is most important that some record of their anatomy should be preserved for the benefit of posterity. Also, contrary to the impression sometimes found among professed zoologists that comparative anatomy is an exhausted subject, little is known of the internal structure of any but the commonest animals. The prosectorium of a large zoological gardens offers the only opportunity of helping to fill these gaps in our knowledge. Such investigations are all the more urgent, since the extensive comparative anatomy collection of the Museum of the Royal College of Surgeons, built up mainly by Sir William Flower and his successors, was destroyed during the air raids—probably the worst single scientific loss of the War. It is hoped that the appointment will attract a student to a branch of zoology which, although rather out of fashion in recent times, remains the framework on which its many activities ultimately depend. Further information concerning the fellowship can be obtained from the Secretary, Zoological Society of London, Regent's Park, London, N.W.8.

War Industries and Town Planning

Two articles, by A. Shenfield and Prof. P. Sargant Florence, reprinted from the *Review of Economic Studies* (1944–45), have a bearing on the siting and development of new towns. The first article, "Labour for the War Industries: the Experience of Coventry", points out that the really important effect of the War upon Coventry is to be seen, not in the physical injuries which the city suffered, but in the conversion of its industries to war purposes and in their expansion to that end. Analysing the character and growth of the population of the city, Mr. Shenfield and Prof. Sargant Florence direct attention to the very high proportion of the workers of Coventry who at the beginning of the War were without roots in the city. This proportion was greatly increased by the enforced war-time expansion of its industries, and the existence of a highly abnormal proportion of such newcomers in the population is regarded as aggravating the problems of war-time production; first, because the outward as well as the inward mobility of the immigrant tends to be higher than that of other workers; and secondly, because with a population largely recruited by the attraction of high earnings and composed of those ready to snatch advantage from slack management, Coventry was likely to show higher costs than some other centres would have done.

In the second paper, "The Economics and Diseconomics of Industrial Concentration: the War-time Experience of Coventry", analysis of such factors as the cost of labour turnover, absenteeism, higher earnings, transport and housing leads to the conclusion that the localization since 1939 of war industries in Coventry on the scale required by the Government's plans, and the immigration they involved, was scarcely justified. The fundamental weakness of the Government's original plans was that it did not envisage the economic conditions of total war. The story of Coventry is the story of a war plan framed not merely in, but also to fit, the conditions of peace; and it is by no means certain that it leaves the city fit to meet the conditions of peace to-day. Before the War, Coventry possessed industries which were prosperous and expanding and which, in spite of the seasonal variations of the making of motor-cars, were fairly diversified. Presumably aircraft production will be cut down, and Coventry will depend mainly on the motor-car industry. Unless all the labour imported since 1939 emigrates, Coventry will require a larger motor-car industry than in 1939, since its other pre-war industries may not have been restored. Moreover, at the end of the War, Coventry was specializing more narrowly than before on trades liable to cyclical as well as seasonal fluctuation. Prof. Sargant Florence and Mr. Shenfield conclude that plans should be prepared to guard against abnormally high unemployment. Diversification with industries not liable to cyclical fluctuation and likely to meet post-war demands for durable goods is required, using as a basis the expansion and fostering of offshoots from the electrical, engineering, metal-working and textile industries, so that Coventry approximates in character to its more balanced neighbours, Birmingham and Leicester.

Chemotherapy

EVERYONE who is interested in chemotherapy should not fail to consult the *British Medical Bulletin*, No. 4, Vol. 4, 1946, the sub-title of which is "Background to Chemotherapy". Introduced by a sketch of the history of chemotherapy by Dr. E. M. Lourie, this issue of the bulletin contains an article on the steps leading to the therapeutic application of microbial antagonism by Sir Howard Florey, one on the analysis of antibacterial action by Dr. H. MacIlwain, and a valuable article on the nutrition of bacteria by Sir Paul Fildes. Dr. F. R. Selbie contributes an article on microbial resistance to chemotherapeutic drugs, Prof. L. P. Garrod deals with the principles and practice of local chemotherapy, and Prof. J. H. Gaddum writes on the principles of administration in chemotherapy. Dr. C. H. Andrewes and Dr. Harold King have written a valuable article on the chemotherapy of the rickettsial and virus diseases.

It is good to see that space is also given to the important chemotherapeutical work done in France, which is summarized in an article on the contribution of the Institut Pasteur, Paris, to recent advances in microbial and functional chemotherapy by four members of the staff of this famous institution, Jacques Tréfouël, Mme. Jacques Tréfouël, Daniel Bovet and Frédéric Nitti. An interesting article by Prof. F. G. Young, entitled "Claude Bernard and Scientific Adventure", pays a just tribute to the work of this great man. The book reviews and the guide to current medical literature continue to be a valuable feature of the bulletin. In this issue there is also a very interesting article on the making of a catalogue of medical films by Dr. Brian Stanford, who is in charge of the reference catalogue of all the films of medical interest in Great Britain, which is being maintained by the co-operation of the Scientific Film Association and the Royal Society of Medicine. Some notes on health education films and some of those produced at the Pasteur Institute are also given.

British Scientific Instrument Research Association

ONE of the first steps taken in the major scheme of expansion which the British Scientific Instrument Research Association is at present engaged in putting into effect was the creation of an Information Department to serve both members and staff. This Department, in April 1946, began the publication of a printed monthly bulletin, consisting of about twenty pages an issue, and containing Association notes, and abstracts of current, including patent, literature relating to scientific instruments. The bulletin, at first, was circulated only to members of the Association, to whom it is supplied free of charge, but, in order that it may be of the greatest possible use to makers and users of scientific instruments, the Council of the Association has now decided to make the bulletin available to non-members at an annual subscription of £2.

The October issue of the bulletin (vol. 1, No. 10) records that the work of transferring the Association's research laboratories from Russell Square, London, to new and much larger premises at Chislehurst, Kent, is making good progress, and it is expected that a substantial section of the chemical laboratories will have been removed by the end of November. The response to the request sent out to members for copies of their catalogues and other publications has been very good, and it is hoped to maintain an up-to-date collection of these in the Association's Library. The offices of the Association are at 26 Russell Square, London, W.C.1. The chairman is Dr. W. H. Eccles; the director of research and secretary, Mr. A. J. Philpot; and the information officer, to whom all communications relating to the bulletin and requests for loan of documents should be addressed, is Mr. C. W. Hanson.

Instrument Practice

WITH the outbreak of hostilities in 1939 a number of important Continental journals disappeared from the literature of instrument technology. Many of these are again becoming available in Great Britain; but there is no doubt that there is room for more published information in this large and varied field of scientific thought. The issue of the first number of a new English publication on instrumentation is, therefore, a matter of great interest. The name of this monthly journal is *Instrument Practice*, and its title page states that it hopes to cover the whole field of instrument technology and instrumentation. Its editorial policy is stated as serving and unifying the interests of instrument makers, users and technologists. The journal is primarily concerned with commercial rather than laboratory instruments, and it also aims at the publicizing of British instruments abroad. It will, therefore, be acknowledged that the new journal has set itself an impressive and ambitious task. A considerable section of the first issue is given to an account of a recent conference in the United States, with commentaries on the papers so brief as to be of little value in many cases. Another section is devoted to reprints of papers read before the Society of Instrument Technology. It is here that the new journal may serve a most useful purpose, as the papers of the Society have not yet been regularly published in any one journal. Permanent features cover new patents, news of the industry, trade and technical publications, particulars of new companies and a diary of forthcoming events.

Claims for War-time Awards for Inventions

The rules of procedure of the Royal Commission on Awards to Inventors were published in September 1946 (*Nature*, September 28, p. 443). About fifty claims arising from the use of inventions by the British and Allied Governments during the War have so far been referred to the Commission. They relate to a wide field of invention and include claims in respect of 'Mulberry', the flail tank, which was first used in North Africa for destroying enemy mines, plastic armour for use on ships, amphibious tanks, the Bailey bridge, the sticky bomb, and many others. Many of these cases raise complicated scientific and legal issues, and the preparation of a case for hearing takes a considerable time. It has, therefore, been necessary to postpone the first public hearing of the Commission; but it is hoped that a case will be ready in the middle of February or the beginning of March. A committee consisting of the chairman, Lord Justice Cohen, the deputy chairman, Mr. Kenneth Swan, and the secretary has been set up to deal with preliminary matters which may arise in a claim before it is ready for hearing before the full Commission.

Blood Group Reference Laboratory

Since the Galton Laboratory Serum Unit (Medical Research Council), formerly at Cambridge, closed in May last, Dr. R. R. Race, the former director, has moved to the Lister Institute, London, where he is in charge of the new Blood Group Research Unit of the Medical Research Council. Dr. A. E. Mourant, who formerly assisted Dr. Race, has become director of the new Blood Group Reference Laboratory of the Ministry of Health. This Laboratory, which is part of the Ministry of Health Blood Transfusion Service, is also at the Lister Institute, and will provide grouping serum and investigate clinical blood-group problems. The juxtaposition of these two laboratories will be of great mutual benefit and ensure the close association of the theoretical and practical sides of this subject. Hospitals and medical men requiring grouping serum should, in the first instance, apply to their local regional transfusion centre, through which grouping serum will be issued.

Astrology in the Hellenistic Age

The study of astrology fascinated mankind for some two thousand years. The fundamental idea was the association of a god with each planet and the transfer of the god's character and mythology to the planet. As a result the planet itself was believed to exercise a direct influence on mankind. A crude form of astrology grew up in Mesopotamia in prehistoric times. But Martin P. Nilsson (*Medd. Lunds Astron. Observ.*, ii, No. 111; 1943) suggests that the great system of astrology properly so called was a product of the Hellenistic age. Though based on the false premise already mentioned, the study of the heavens was scientific, and was the result of the labours of a number of scientific observers in the Hellenistic world.

Announcements

The Gold Medal for 1947 of the Royal Astronomical Society has been awarded to Prof. M. G. J. Minnaert, of Utrecht, for his outstanding contribution to solar physics in general and solar spectrophotometry in particular.

The annual general meeting of the Royal Meteorological Society will be held on January 22 at 5 p.m., when Mr. G. Manley will deliver his presidential address on "The Geographer's Contribution to Meteorology". The Symons Medal will be presented to Prof. David Brunt, in recognition of his distinguished services to meteorological science.

Prof. P. C. Sarbadhikary, professor of botany, University of Colombo (Ceylon), has been appointed Sir Rash Behari Ghosh professor of botany in the University of Calcutta in succession to Prof. S. P. Agharkar, who retired in May.

Mr. Ronald Ede has been appointed agricultural attaché to the British Legation in Copenhagen. Mr. Ede, who is forty-one years of age, has been secretary of the University School of Agriculture at Cambridge since 1929. He was secretary of the Luxmoore Committee on Post-war Agricultural Education which reported in 1943.

Mr. W. J. Drummond, deputy chairman of the North-Western Divisional Coal Board, has been appointed honorary secretary of the British National Committee of the World Power Conference, in succession to the late Mr. C. Rodgers.

Colonel L. W. Harrison has retired from the staff of the Ministry of Health, to which he has been adviser on venereal diseases since 1919. Colonel Harrison has been associated with the control of venereal diseases in England and Wales for nearly half a century. In recognition of his work the American Social Hygiene Association awarded him the William Freeman Snow Medal for 1946. He is the author of a number of books and papers on venereal disease.

The following have been elected officers for 1947 of the New York Academy of Sciences: *President*, Dr. Harden F. Taylor; *Vice-Presidents*, Dr. Robert B. Sosman, Dr. S. Stansfeld Sargent, Dr. Ross F. Nigrelli, Walter Dyk, Bernhard Haurwitz; *Recording Secretary*, Dr. George B. Pegram; *Corresponding Secretary*, Prof. Athelstan F. Spilhaus; *Treasurer*, Marvin D. Thorn; *Librarian*, Prof. Victor K. La Mer; *Editor*, Dr. Roy Waldo Miner; *Members of Council* (1947–49), William Brown Bell, Harry C. Charipper, Dr. Caryl P. Haskins; *Finance Committee*, Addison Webb (chairman), William Ottis Sweet, Dr. Charles N. Frey.

LETTERS TO THE EDITORS

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Multiple Disintegration Processes Produced by Cosmic Rays

Some months ago, in collaboration with D. L. Livesey and L. V. Chilton[1], we described experiments on the prototype of the new photographic emulsions for the detection of fast protons and other heavy particles, which are now being produced by Ilford, Ltd., in various types and which are referred to as 'Nuclear Research Emulsions'. Our experience with these plates strongly suggested that they would be very suitable for detecting the multiple disintegration phenomena produced by the fast neutrons, γ-rays and other radiations in the cosmic rays[2,3,4,5]. We therefore exposed plates for six weeks at the Pic du Midi, Hautes Pyrenées, at a height of 3,800 metres, and in this communication we wish to direct attention to the important conclusions which can be drawn from an examination of the experimental material thus obtained.

In addition to the numerous long isolated tracks, which show a grain spacing characteristic of fast protons of energy up to 30 MeV., we observe, in emulsions of type $C2$, 40 μ thick, an average of two multiple disintegration 'stars' per sq. cm. of the plate. Up to the present, we have found more than three hundred events of this type. To avoid confusion due to any radioactive contamination of the emulsion, we accept for detailed study only those 'stars' in which there are three or more components, at least one of which has a range greater than 10 cm. of standard air. From the total area of our exposed plates, we conclude that we shall find about three thousand stars in a complete examination. We believe that this material is sufficiently extensive to enable us to establish regularities in the modes of disintegration of the light and heavy elements under bombardment with primary radiations of great energy.

We cannot, within the scope of a single communication, discuss the many interesting and novel events we have observed; but, as an example of the quality of the experimental material, we show, in Figs. 1 and 2, mosaics of photomicrographs of two comparatively simple disintegrations. We chose to photograph these particular 'stars' because they were among the first which we observed and they were of such a type that the work of constructing the mosaics was not unduly arduous. At the points where the track of each of the particles, radiating from the disintegrating nucleus, reaches the edge of the photograph, we show the total range of the corresponding particle in the emulsion, and indicate whether it ends in the emulsion (e), passes out of the surface (s), or into the glass (g). In making prints of the photographs for reproduction, the joins of the mosaic have been obliterated. At no stage in the photography, however, has any 'retouching' been done.

Fig. 1 shows a multiple disintegration in which the most prominent track, A, has a grain spacing characteristic of an α-particle. It ends in the emulsion and, from its observed range of 505 μ, we can conclude that its initial energy, at the moment of its ejection from the parent nucleus, was 36 MeV.[6]. The thinner tracks B, C, D, E, G and H have a grain spacing similar to that of protons of familiar energies ($\sim$ 20 MeV.), and they all pass out of the emulsion, while F, which passes into the glass, is probably an α-particle. In addition, the tracks of at least two short, very heavily ionizing particles can be distinguished in the original photographs.

Fig. 2 shows a multiple disintegration in which the two long tracks (Z) and (Y) are produced by protons. Z has a range of 290 μ (energy, 6·8 MeV.) and ends in the emulsion, while Y passes out of the surface after traversing a distance of 400 μ. The other tracks all leave the emulsion, so that we cannot make a certain identification of their nature; but, if their energies are each less than 30 MeV., (X) and (W) are protons and (V) is an α-particle.

The most striking feature of this second photograph is the 'hammer' track (T), in which the end of a heavily ionizing particle from the source is crossed by a second track in the form of a 'T'. It is possible that the cross-track is due to an α-particle of which the trajectory passes, by chance, within one micron of the end of the track of the particle from the 'star', and we observe tracks of approximately the same range and grain spacing throughout the plate. From the number of such tracks per unit volume of the emulsion we can, however, calculate the probability of the observed juxtaposition if it is to be explained as a chance event. We obtain a value less than 1 in 10^5, and we must therefore look for an alternative explanation.

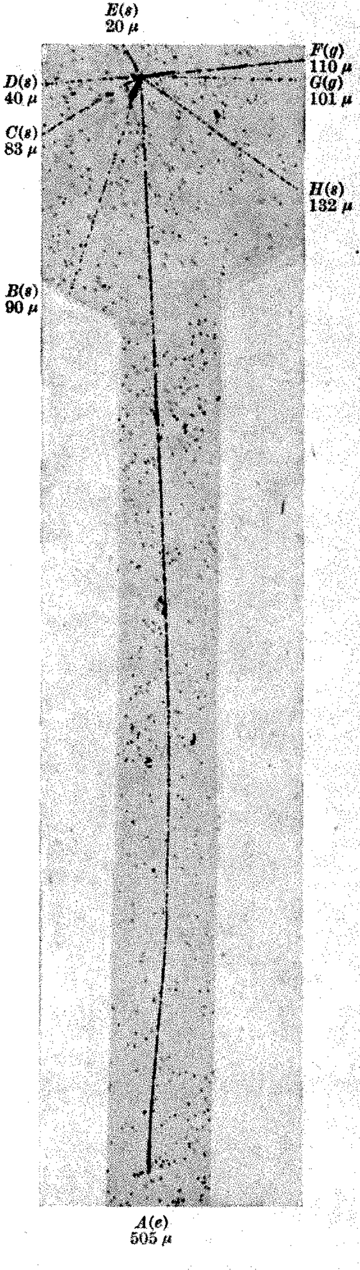

Fig. 1. Mosaic of twelve photomicrographs showing the multiple disintegration of a nucleus of silver or bromine. The different tracks are not all in the same plane and, with objectives of high aperture, several photographs must be taken to obtain a complete representation of the subject

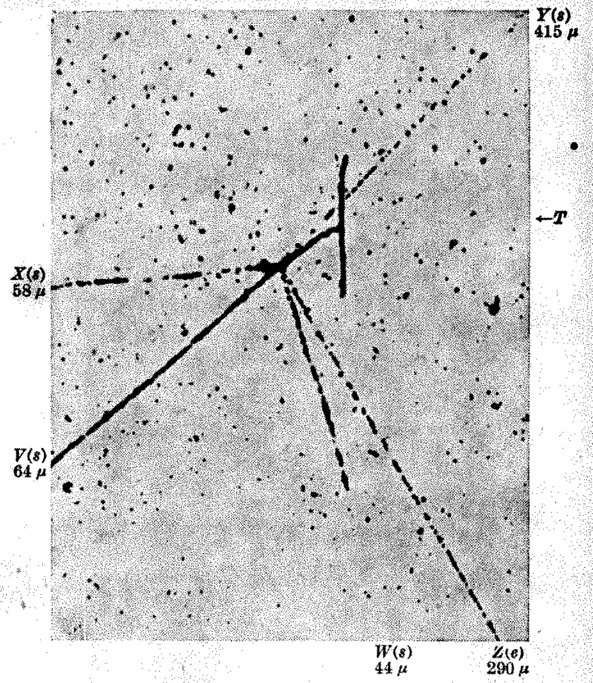

Fig. 2. MOSAIC OF SIX PHOTOMICROGRAPHS. THE COMPLETE HAMMER TRACK WAS OBTAINED IN A SINGLE PHOTOGRAPH

A microscopic examination of track *T* at high magnification indicates that the particle from the exploding nucleus is more heavily ionizing than an α-particle. The track shows the characteristic distorted appearance—a wavy kris-like structure—which occurs when there are so many developing particles in it that their expanding filamentous form during development causes the column of silver grains to buckle. This effect is not found at the end of the long α-particle track shown in Fig. 1, and this is in accord with our general experience with α-particle tracks in the *C*2 emulsion. We may therefore assume that the track is produced by a heavy nuclear splinter. The cross-track of the *T* is then to be attributed to the disintegration of the heavy particle, after it has been brought to rest, into two fragments which recoil in opposite directions. Since the two arms of the cross-track are of nearly equal length, 13·1 and 14·4 μ respectively, we must assume, on this view, that the two particles are of equal mass. If, as the simplest example of such a disintegration process, we assume the nuclear fragment to be an excited Be^{8} nucleus which decomposes into two α-particles, the observed ranges of the tracks indicate that the energy in the excited state is 7·5 MeV. Serious difficulties arise, however, if we assume the fragment emitted from the explosion to be such an excited nucleus.

The speed of the recoiling nuclear fragment must be of the order of 2×10^{9} cm. per sec. The time it takes to reach the end of its trajectory, 16 μ long, is therefore about 10^{-12} sec. Since the two component particles into which we regard it as decomposing are emitted in opposite directions, the velocity of the original Be^{8} nucleus must have been small or zero at the moment of its decay. We must conclude that the life-time of the excited state is greater than 10^{-12} sec. Such a relatively long life corresponds to a width in the excited level of only a small fraction of an electron-volt. This is in contrast with the excited state of Be^{8} at 2·9 MeV., which is known to have a width of several hundred KeV. and a correspondingly short life. We must therefore assume the existence of a metastable level in Be^{8}.

These difficulties can be overcome if we assume the original fragment to be a Li^{8} nucleus. It has been shown that this nucleus suffers a β-decay, with a period of 0·8 sec., in which two α-particles appear, together with the electron. The α-particles have a continuous distribution in energy extending from low values up to 7·75 MeV. Our observations are therefore consistent with the assumption that the fragment from the exploding nucleus is Li^{8}.

Whether or not this particular observation is to be attributed to chance, our observations of several other equally striking events make it clear that multiple disintegration phenomena of this type cannot be accounted for in terms of conventional ideas in nuclear physics, and that we are entering a realm of great theoretical and experimental interest. It is clear that for such experiments the new photographic emulsions give us an instrument of considerable power. Among the other advantages of the method, which are gradually being recognized, we may point out that for this particular type of experiment it allows us to measure time intervals about a thousand times shorter than would be possible in similar experiments using the expansion chamber. The investigation is continuing.

We are indebted to Prof. J. Baillaud, director of the Observatory of the Pic du Midi, for permission to use the facilities of the Observatory and for much kindness and hospitality. To him, to our friend Prof. Max Cosyns, without whose assistance we should not have succeeded in making the exposures, and to Mr. C. M. G. Lattes, who assisted with the preparation of the material for the experiments, we wish to express our grateful thanks.

(*Note added in proof.*) We have observed a second multiple disintegration star which shows a 'hammer' track with equal branches at the 'T'. In other cases we found that the nuclear fragment decays into two and sometimes three fragments before coming to rest.

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[1] Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, **23**, 102 (1946).
[2] Heitler, Powell and Heitler, *Nature*, **146**, 65 (1940).
[3] Blau and Wambaker, *Sitz. Acad. Wien*, **146**, 623 (1937).
[4] Schopper and Schopper, *Phys. Z.*, **40**, 22 (1939). For other references see Shapiro, *Rev. Mod. Phys.*, **13**, 58 (1941).
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[6] Lattes, private communication.

A Theory of the Control of Twinning in Quartz

IN a previous communication in *Nature*[1] some experiments in connexion with the controlled alteration in the twin boundaries of electrically twinned quartz have been described. The following theory satisfactorily accounts for the production of substantially single-crystalline specimens by the application of a torque at temperatures somewhat lower than the α-β transition point (573° C.).

If a plate of twinned material is cut parallel to an arbitrary direction relative to the crystallographic axes and then twisted about an axis parallel to its length, the elastic energy per unit volume stored in each of the two individuals constituting the twin is different. The crystal of the first orientation in the twin may be more easy to twist than that of the second orientation, and will, in consequence, have more elastic energy per unit volume. According to the present theory, that orientation tends to predominate after the thermal and mechanical treatment which permits the crystal to twist as far as possible under a given torque.

This may be expressed quantitatively in the following manner. The expression for E, the elastic energy per unit volume of the crystal, will be of the form

$$E = \Sigma \tfrac{1}{2} t_{ik} r_{lm},$$

where t_{ik} and r_{lm} represent the stress and strain components respectively, and the summation is to be made over all the values for which i, k, l and m are independently made equal to 1, 2 and 3. This complete expression is too complicated to evaluate in most practical cases, but for torque applied to a long thin bar it is possible to simplify it. The predominant stress component for this type of experiment is a shear, tending to make a square drawn on the surface of the plate, with one edge parallel to the length of the plate, turn into a rhombus. The expression for E then becomes,

$$E = t'_{23} r'_{23},$$

where the X_3' axis is chosen parallel to the length of the bar and the X_2' axis parallel to the breadth.

Now since $s'_{23} \ll s'_{44}$, $r'_{23} = s'_{44} t'_{23}$, if all stress components other than t'_{23} may be neglected.

$$\text{Thus } E = s'_{44}(t'_{23})^2.$$

The orientation of the crystal in one part of the twin is derived from that in the other part by a rotation through 180° about the trigonal axis. The modulus s'_{44}, which applies to one part of the twin, differs in magnitude from the modulus s''_{44}, which applies to the other part of the twin in the same crystal plate. The change of energy per unit volume in changing from one orientation to the other is therefore ΔE, where

$$\Delta E = (s''_{44} - s'_{44})(t'_{23})^2.$$

From the standard expression for s'_{44} the value of $s''_{44} - s'_{44}$ may be evaluated in terms of the angles ξ and θ, where ξ is the angle between the projection of the normal to the major surface of the plate on to the (00*1) plane, and the diad axis and θ is the angle between the same normal and the trigonal axis. This value is given by the equation,

$$s''_{44} - s'_{44} = -4 s_{14} \sin 2\theta . \sin 3\xi.$$

The geometrical model which can be constructed from this equation, by making each radius vector defined by ξ and θ of length equal to $(s''_{44} - s'_{44})$, has the form and symmetry of the figure derived experimentally and published in the previous communication[1]. Further, the experimentally observed direction of the electric axis in a crystal untwinned by the application of a torque agrees with that required by the theory. There appears to be no direct determination of the variation of s_{14} with temperature over the whole range 20°–573° C., but, if this variation is similar to that of the other elastic moduli which have been measured, it is not likely to alter the applicability of the theory here proposed until a temperature close to 573° C. is reached. A satisfactory theory is therefore given of the behaviour under torque of twinned plates of various orientations having their lengths perpendicular to the trigonal axis.

Following on the lines of the above theory, Mr. L. A. Thomas, of the Research Laboratories of the General Electric Co., Ltd., Wembley, has calculated the expression for $s''_{44} - s'_{44}$ for a plate of completely general orientation, thus including the case of plates having their lengths inclined to the diad axis. When applied to R-cut and r-cut plates having their lengths inclined at an angle of 45° to the diad axis, the agreement between the theory and experiment still holds. The theory shows that the sign of ΔE is reversed relative to that in plates of otherwise the same orientation but having their lengths parallel to the diad axis. This corresponds to the experimental fact that in two R-cut plates, one having its length parallel to the diad axis and the other having its length at 45° to this axis, complementary orientations are stable under the torque-and-heat treatment. This agreement between the simple theory and experiment is obtained in spite of the fact that, on twisting plates of such general orientation, bending occurs as well as twisting. It would not have been surprising if the simple theory outlined above had proved inadequate for plates of general orientation.

This work, of which a fuller account will be published elsewhere, has been done in co-operation with the Research Laboratories of the General Electric Company, Ltd., Wembley, and I am grateful to the Director for permission to publish. I also wish to acknowledge my indebtedness to Mr. R. S. Rivlin for valuable discussions on this subject.

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[1] Wooster, W. A., and Wooster, Nora, *Nature*, 157, 405 (1946).

Crystal Structure of Copper Butyrate Monohydrate

VERY few soaps or other similar substances have been examined by means of the X-ray single-crystal technique because of the difficulty of obtaining crystals which are large enough, and particularly crystals which are thick enough. Consequently, there are few data on the unit cell dimensions. Copper butyrate, however, when crystallized by allowing an acetone solution to evaporate at room temperature, gives unusually large and comparatively thick crystals in the form of six-sided plates frequently twinned on the large face. They are of a deep green colour, and on exposure to the air for a day or so the faces become dull, the crystals ultimately disintegrating.

Dehydration experiments carried out in an atmosphere with a partial water-vapour pressure of 13 mm. mercury showed that one molecule of water was lost between 42° and 47° C. Analytical data also confirmed the presence of water of crystallization.

According to Groth[1], the monohydrate is described as triclinic pinakoidal ($a : b : c = 1{\cdot}6921 : 1 : 0{\cdot}9993$, $\alpha = 88° 55'$, $\beta = 123° 51'$, $\gamma = 88° 25'$). The present crystals, however, are monoclinic, the large face being $\{001\}$. Rotation, oscillation and moving-film photographs were taken about the three principal axes and about the diagonal of the bc face of the unit cell using copper $K\alpha$ radiation. The unit cell dimensions are as follows:

$a = 25{\cdot}12$ kX.; $b = 14{\cdot}65$ kX.; (c) $26{\cdot}79$ kX.; $\beta = 109{\cdot}7°$; d (001) = $25{\cdot}23$ kX. Density (obs.) = $1{\cdot}44$ gm./cm.^{3}; density (calc.) = $1{\cdot}45$ gm./cm.^{3} (assuming 32 molecules of $(CH_3.CH_2.CH_2.COO-)_2Cu.H_2O$ per unit cell).

The observed halvings were $\{hkl\}$ when $(k + l)$ is odd and $\{h0l\}$ all halved.

The space group is, therefore, $C_s^4 - Aa$ or $C_{2h}^6 - A2/a$. In the former space group, four asymmetric units are necessary, so that each unit would consist of eight molecules, whereas only four molecules per asymmetric unit are necessary in the latter space group. It is rather unusual for such a large number of molecules to be required.

I am indebted to Mr. Lang for preparing this compound, and to Dr. Vand and Mr. Lomer for carrying out the dehydration experiments. I wish to thank the director of the Chester Beatty Research Institute of the Royal Cancer Hospital (Free) for the loan of some apparatus, and the directors of Lever Brothers and Unilever, Ltd., for permission to publish these results.

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Response of Photoconductive Lead Sulphide Cells

IN a recent communication, the possibility of using photoconductive lead sulphide cells for the measurement of rapidly varying surface temperatures has been emphasized[1]. For this purpose it is, of course, desirable that the response time of the measuring instrument be sufficiently small, and it is therefore of interest to see whether on theoretical grounds it is possible to decrease the response time of the cells. In this connexion it is important to remember that the conduction electrons can be captured both by the ionized impurities (n per c.c.), the number of which increases with increasing temperature, and by interstitial ions. At ordinary temperatures the equilibrium number of the latter (Frenkel defects) is very small; however, under suitable conditions of manufacture, a large number (M per c.c.) corresponding to a high-temperature equilibrium can be 'frozen-in'. The number of conduction electrons released by radiation (I per c.c. per sec.) and heat agitation (A per c.c. per sec.) is then determined by the equation

$$\frac{dn}{dt} = I + A - Bn(n + M),$$

the capture coefficients of the ionized impurities and interstitial ions being assumed equal for the sake of simplicity. The time t_α taken to obtain the fraction α of the full asymptotic response is, therefore, given by

$$2B(n_0 + \tfrac{1}{2}M)\, t_\alpha = \frac{1}{\delta} \log \frac{\delta + 1 + (\delta - 1)\alpha}{(\delta + 1)(1 - \alpha)},$$

where

$$\delta = \sqrt{1 + \frac{I}{B(n_0 + \frac{1}{2}M)^2}} = \sqrt{1 + \frac{(n_\infty - n_0)(n_\infty + n_0 + M)}{(n_0 + \frac{1}{2}M)^2}};$$

$$n_0 = n\,(t = 0), \qquad n_\infty = n\,(t = \infty).$$

Hence, if $M \gg n$,

$$t_\alpha = \frac{1}{BM} \log \frac{1}{1 - \alpha},$$

whatever I may be.

On the other hand, if $M \ll n$,

$$t_\alpha = \frac{1}{2Bn_0} \log \frac{1}{1 - \alpha} \text{ for small } \delta - 1,$$

$$t_\alpha = \frac{1}{2Bn_0\delta} \log \frac{1}{1 - \alpha} = \frac{1}{2\sqrt{IB}} \log \frac{1}{1 - \alpha} \text{ for}$$

large $\delta - 1$.

As B varies probably only slowly with temperature, the first formula shows that in the case $M \gg n$ the response time is almost independent of temperature but varies inversely as M. As distinct from this case, the response time decreases exponentially with increasing temperature of the cell if $M \ll n$, owing to the exponential increase of n_0 for semi-conductors. The case of large $\delta - 1$ requires too high intensities of radiation to be important in practice.

It is to be expected that the case of a large number of 'frozen-in' capturing centres will be realized in practice if there is a large and rapid drop in the diffusion coefficient of the Frenkel defects during the manufacture of the cell[2]; for example, if the lead sulphide film is obtained by evaporation at a high temperature and sublimation on a cool support. The higher the temperature at which the film is formed, and the cooler the support, the larger M will be, that is, the smaller the response time t_α. The other case, $M \ll n$, can be expected to apply to cells made at ordinary temperatures, for example, by chemical precipitation.

It must be pointed out that the decrease in response time is accompanied by a corresponding decrease in response (signal), the asymptotic number of photoelectrons being given by

$$n_\infty - n_0 = \frac{I}{2B(n_0 + \frac{1}{2}M)} = \frac{It_\alpha}{-\log(1 - \alpha)}.$$

Conversely, the formula shows that, at a loss of speed of response, the sensitivity of the cells can be increased by the methods indicated.

Details and comparison with experiments will be given elsewhere. I have to thank the Director-General of Scientific Research (Defence), Ministry of Supply, for permission to publish the present communication.

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[1] Lee, E., and Parker, R. C., *Nature*, 158, 518 (1946).

[2] Mott and Gurney, "Electronic Processes in Ionic Crystals" (Oxford, 1940).

Temperature Dependence of the Intensities of Raman Lines

I HAVE undertaken the critical and exhaustive study of Placzek's polarizability theory of Raman scattering. My investigations have been carried out both with solids and liquids, and the following observations made: (1) The intensity of the Stokes lines decreases with the rise of temperature, while according to the theory there should be an increase. (2) The intensity of the anti-Stokes lines, in general, increases with the increase of temperature, but not to the extent that would be expected from Placzek's theory. (3) The intensities of the Stokes and the anti-Stokes lines tend to meet each other at some finite value, while from the theory we should expect the intensities of the Stokes and the anti-Stokes lines to become large at high temperatures and to tend to meet each other at infinite intensity. (4) The ratio of the intensities of the Stokes and anti-Stokes lines, at all temperatures, is in agreement with the result expected from Placzek's theory.

The polarizability of a molecule may be expanded as a series

$$L(q) = L_0 + \sum_j \left(\frac{\partial L}{\partial q_j}\right)_0 q_j + \tfrac{1}{2}\sum_{jk} \left(\frac{\partial^2 L}{\partial q_j\, \partial q_k}\right)_0 q_j q_k + \ldots,$$

where the suffix 0 refers to the equilibrium configuration, q_j, q_k, etc., are the various normal coordinates of the molecule, and a particular set of values of q_j, q_k, etc., define a configuration q of the molecule. The conclusions from Placzek's theory are arrived at by taking the factor $\left(\frac{\partial L}{\partial q_j}\right)_0$ as constant at various temperatures. Taylor's expansion is valid only in the close vicinity of the equilibrium configuration. But as the temperature is increased, the amplitudes become larger, and we can no longer assume that Taylor's expansion, which is taken in the neighbourhood of the equilibrium configuration, is valid. Therefore, $\left(\frac{\partial L}{\partial q_j}\right)_0$ cannot be regarded as constant. It will decrease rapidly with the increase of temperature. The observed results can be explained on this basis.

A detailed explanation will be published elsewhere.

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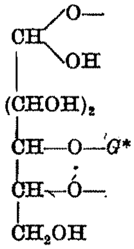
Structure of Starch and Cellulose

ALTHOUGH the characteristic features of the chemistry of starch and cellulose are satisfactorily represented by the commonly accepted structures involving chains of glucopyranosido residues, which are unbranched in cellulose and amylose, but branched in amylopectin, certain difficulties remain to be explained. These include, for example, the exact nature of the relationship between the amylose and the amylopectin components of the starches, and the reasons for the different behaviour of cellulose on methylation in the presence and in the absence of oxygen respectively.

In an attempt to overcome very real difficulties of this kind, Pacsu and Hiller[1] have recently advocated a novel structure for these polysaccharides based on the assumed occurrence of a small proportion of non-cyclic hemiacetal linkages. This is a modification of the Tollens acetal structure for cellulose, and the essential feature of it as applied to starch is shown in (I), which depicts a maltose residue in a hemiacetal form serving as a link between long chains of 1 : 4 linked glucopyranosido residues. The glucose residue marked with an asterisk is an end-group, and Pacsu and Hiller apparently postulate a sufficient number of these cross-linkages to account for the number of end-groups as determined by the methylation method. It is not possible, therefore, to decide on the results of methylation experiments alone whether or not such a formula is valid for a starch.

Other methods of approach to the problem of end-group determination have recently been developed, and by application of one of these we have obtained evidence from which it appears that the type of linkage suggested by Pacsu and Hiller does not occur in starches. Inspection of (I) reveals that the presence of hemiacetal linkages increases the number of contiguous hydroxyl groups at which oxidative attack by the periodate ion is possible, with the result that from the structure shown in (I) three molecules of formic acid would be formed for every terminal glucose residue (G^*). Actually, on the basis of the much more complicated detailed formula depicted by these authors, considerably more than three molecules of formic acid per end-group would be liberated, with the simultaneous formation of a large number of fragments of smaller molecular weight.



(I)

It has been found, however, by use of methods elaborated recently for the quantitative liberation and estimation of formic acid in periodate oxidations of polymeric glycosides[2], that starches yield only one molecule of formic acid per end-group. This result is in agreement with the expected value if amylopectin possesses the 'laminated' structure[3], but is incompatible with Pacsu and Hiller's formula.

In other respects also the newly proposed structure appears to be incapable of reconciliation with experimental observations. For example, investigations on the kinetics of the 'disaggregation' of starch have shown that the bonds broken in the reaction have the stability of glycoside links towards acid, and require no novel type of bonding to explain their properties[4]. Furthermore, it is difficult to see how the results of enzymic hydrolysis and dextrin formation could be explained by structures involving hemiacetal linkages of the type shown in (I).

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[2] Jackson, E. L., and Hudson, C. S., *J. Amer. Chem. Soc.*, 58, 378 (1936); 59, 994 (1937). Brown, F., Dunstan, Sonia, Halsall, T. G., Hirst, E. L., and Jones, J. K. N., *Nature*, 156, 785 (1945).

[3] Haworth, W. N., Hirst, E. L., and Isherwood, F. W., *J. Chem. Soc.*, 577 (1937).

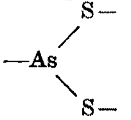
[4] Bawn, C. E. H., Hirst, E. L., and Young, G. T., *Trans. Faraday Soc.*, 36, 880 (1940).

Effects of Organic Arsenic Compounds on Tissue Enzymes and Proteins and on Tissue Metabolism

IN connexion with recent interesting reports, both in Great Britain and in the United States, on the relationship between organic arsenicals and enzymes containing thiol groups, we would like to take the opportunity of directing attention to some early observations of our own, incorporated in a report to the Medical Research Council in November 1940.

The following extract from this report gives our conclusions based on investigations, carried out in the Cardiff City Mental Hospital during 1938, 1939 and early 1940, on the effects of organic trivalent and pentavalent arsenic compounds on proteins and enzymes.

"(1) Reversible equilibria exist between pentavalent arsenic compounds (such as tryparsamide) or trivalent arsenic compounds (such as arsphenamine and derivatives of phenylarsenoxide) and purified tissue proteins. The affinity of organic arsenoxides to the proteins is far greater than that of pentavalent arsenic compounds. Affinity constants have been measured and new methods for analysis of $\mathrm{As}^{\mathrm{III}}$ and As^{V} in presence of proteins elaborated. Compounds of the type R.As.O combine reversibly with —SH groups of the protein and with other as yet unknown groupings.

"(2) Certain compounds of the type R.As.O (e.g., meta-amino-*p*-hydroxyphenylarsenoxide, also known on the market as 'mapharside') combine reversibly with —SH enzymes. They can be regarded as specific inhibitors of this class of enzymes, which includes urease, succinic dehydrogenase and choline esterase. It is proved for the first time by this means that choline dehydrogenase is an —SH enzyme. Enzymes known not to possess —SH groups as part of their active centres, e.g., invertase, catalase, lactic dehydrogenase, cytochrome oxidase are unaffected by R.As.O. The toxicity of R.As.O to enzymes is neutralised by the addition of —SH compounds, e.g., cysteine, in large excess. These condense with R.As.O to form easily dissociated compounds, and excess —SH is required to keep most of the —AsO in the form of the inert  $-\mathrm{As}\begin{matrix}\diagup\mathrm{S}- \\ \diagdown\mathrm{S}-\end{matrix}$ derivative.

"Compounds of the type R.As.O and R.As.Cl_2 also inhibit vigorously the respiration of intact cells in presence of glucose and sodium pyruvate. Such cells vary from intact brain tissue to bacterial suspensions. The oxidation of pyruvate and possibly other ketonic acids is greatly inhibited, and ketonic acids accumulate. The addition of —SH compounds in excess neutralizes R.As.O inhibition of the metabolism of intact cells.

"Compounds of the type R.As.O and R.As.Cl_2 are also highly bactericidal but the addition of —SH neutralises the lethal action.

"(3) Pentavalent arsenic compounds, e.g., tryparsamide and atoxyl, are reduced by —SH compounds (e.g., cysteine, glutathione) under biological conditions to the highly toxic trivalent —AsO derivatives. This may be demonstrated by the effects of the products of reduction on —SH enzymes (e.g., urease) and on intact cells. The reduction of tryparsamide in the body is doubtless accomplished by the —SH bodies (e.g., glutathione) present."

This work was undertaken as part of a programme to elucidate the mechanism of action of arsenicals in the treatment of syphilis of the central nervous system, and part of it was carried out with the assistance of Mr. W. J. Clarke.

The publication of these results was not allowed during the War for security reasons. Owing to war work we became separated, and only recently have we had the opportunity of reconsidering our early work for the purpose of publication.

The experimental results upon which the above conclusions have been reached will, it is hoped, be published shortly. We are much indebted to the secretary of the Medical Research Council for permission to publish the extract of the report in question.

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Dec. 17.

Splitting of Phosphocreatine

IT is generally assumed that when phosphocreatine is hydrolysed either enzymatically or spontaneously, the end products are creatine and phosphoric acid. This, however, is not always found to be the case. When phosphocreatine is hydrolysed at 38° in saturated picric acid, about 10 per cent of the substance is converted into creatinine (Fig. 1). Under these conditions, creatine is not transformed into creatinine. Obviously phosphocreatine has a certain spontaneous tendency to ring formation. If heated to 100° either in picric acid or hydrochloric acid, there is a rapid formation of creatinine, followed by a linear increase due to the reaction creatine – creatinine (Fig. 2). If the two curves are subtracted, a curve of much the same appearance as Fig. 1 results. Whether picric or hydrochloric acid is used for hydrolysis is of no importance.

The phenomenon described may possibly be developed into a specific method for the estimation of phosphocreatine in blood and other tissues. Generally this substance is estimated as the difference ('direct determinable' P — 'true' inorganic P), thus neglecting other labile phosphorus compounds which may be present.

These experiments may perhaps throw some light on the creatinine formation in living organisms. It is well established that the daily excretion of creatinine

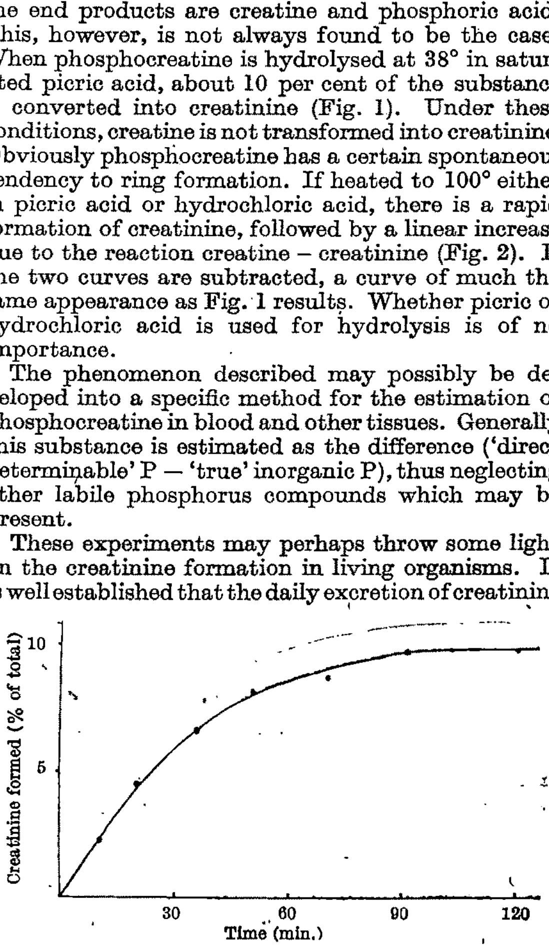

Fig. 1. FORMATION OF CREATININE FROM PHOSPHOCREATINE IN 8/9 SATURATED PICRIC ACID AT 38°. CONC., 0·35 MM./L.

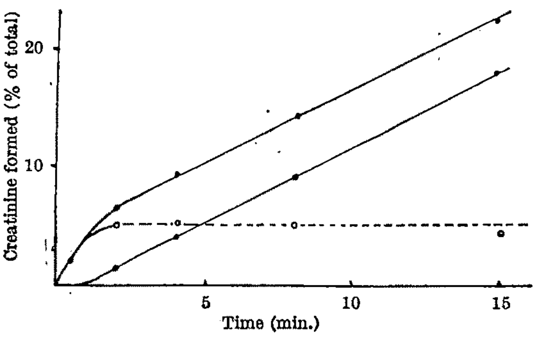

Fig. 2. FORMATION OF CREATININE FROM PHOSPHOCREATINE (UPPER CURVE) AND CREATINE (LOWER CURVE) AT 100° IN 8/9 SATURATED PICRIC ACID. – – – – – –, THE DIFFERENCE BETWEEN THE TWO CURVES. CONCENTRATIONS, 0·35 MM./L.

is rather closely proportional to the total amount of muscle tissue and independent of muscular activity. This may be explained if it is assumed that there is a spontaneous breakdown of phosphocreatine resulting in the formation of some creatinine. The phosphocreatine breakdown through specific activity yielding the energy-rich phosphate group to some acceptor can readily be imagined to give rise to no creatinine formation, thus explaining why the creatinine output is independent of muscular activity.

Another problem which may perhaps be attacked on the basis of the present observation is the active renal secretion of creatinine.

According to the hypothesis that a necessary condition of renal tubular secretion is that the substance is an acid[1], creatinine should not be secreted; and it is in fact the only substance not found to obey this rule, at least in mammals.

Rehberg[2] has suggested that phosphocreatine, known to occur in plasma after the injection of creatinine[3], may be converted into creatinine in the tubular cells and thus be responsible for part of the urinary creatinine. This suggestion seems to find support in the observation that phosphocreatine may form creatinine spontaneously. The tubular cells are supposed to exhibit a strong non-specific phosphatase activity, thus making possible a partial conversion of phosphocreatine into creatinine. That phosphocreatine should be absorbed from the blood stream by the tubular cells is well in accord with the hypothesis mentioned[1].

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[1] Lundquist, F., *Acta Pharm. et Tox.*, 1, 307 (1945).

[2] Rehberg, P. B., XVI Int. Physiol. Kongress, *Kongressber.*, 1, 4 (1938).

[3] Abdon, N-O., *Kungl. Fysiograf. Sällsk. i Lund Förhandl.*, 5, 14 (1935).

Preparation of Cell-free Tryptophanase

IN our earliest studies on the tryptophanase complex[1] active non-viable suspensions of *E. coli* were used. These had been sterilized by shaking with chloroform, 1 volume to 2 volumes of suspension. The mixture was shaken vigorously to 200 r.p.m. for 4 hours.

An active dry enzyme preparation was also prepared by precipitation of the cells with 66 per cent alcohol (at 0°) and subsequent washing with ice-cold absolute alcohol. Since at that time we were mainly concerned with the mechanism of the reaction, further work was not attempted; though occasional studies on the supernatants from viable cells suggested that the enzyme complex could be obtained as a cell-free preparation. More recently we have been concerned to know more of the nature of the enzyme complex, and the following represents the preparation of such a cell-free preparation and which, moreover, can be divided into a dialysable and non-dialysable portion.

Cells grown for 22 hours at 37° on a tryptic digest of cæsin solidified with agar were harvested, washed and filtered through glass wool. Thick creamy suspensions thus obtained were cooled in ice and poured into five volumes of ice-cold acetone with constant stirring. The flocculated cells were allowed to settle and then filtered off with gentle suction on a Buchner funnel, washed successively with acetone, acetone and ether, and finally ether, and dried in a desiccator.

Tests were made with buffer solutions of *p*H 5, 7 and 9 to extract the enzyme from the powder. After overnight extraction, the suspensions were centrifuged and supernatants adjusted to *p*H 7·4. Activity of extraction was nil at *p*H 5, faint at 7 and more marked at 9.

The present technique employed is overnight extraction with borate buffer *p*H 8·6 using 20 mgm. acetone-dried powder per ml. buffer. Whereas the optimum *p*H for the reaction by the intact organism is 7·6, the cell-free enzyme has an optimal *p*H range of 8–8·5. The activity obtained from such cell-free extracts has been, at the maximum, approximately 25 per cent of that obtained from intact organisms, presumably due to destruction of some portion(s) of the tryptophanase complex by acetone drying.

Dialysis of the cell-free extract has been performed, and both dialysate and protein portion have been shown to be inactive by themselves. When added to one another activity was regained.

Work is now in hand on the elucidation of the various factors of the enzyme complex, and a full report will be published at a later date.

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[1] *Biochem. J.*, 29, 1918 (1935).

Yeast and Rickets

IN his address to the Seventh Congress of Biological Chemistry in Liège on October 3–6, 1946, Dr. H. D. Kay summarized some experiments on feeding pigs with yeast, carried out during the War at the National Institute for Research in Dairying in Reading[1]. It was found that when the total food ration contained 8 per cent dried yeast, some of the animals developed stiffness and lameness, and were finally unable to stand. If the diet contained 20 per cent yeast, this condition developed rather rapidly in all pigs. X-ray examination of the bones indicated that the pigs were, in fact, suffering from rickets. The rachitic symptoms could be prevented by a sufficient supply of vitamin D, and could be almost completely prevented by increasing the calcium carbonate content of the diet from 1·5 to 4 per cent. When the yeast phosphorus was replaced by the corresponding amount of sodium phosphate phosphorus, no symptoms were produced.

During a recent visit to England, I discussed this problem with the Reading workers, who were now of the opinion that the rachitogenic effect of yeast might be connected with the high phytic acid content in the diet. The results of our experiments, which show that dried yeast is a strong inhibitor of the enzyme phytase, support this hypothesis.

The experiments were made on a crude enzyme solution extracted from rye bran. 25 ml. of the solution correspond to the phytase activity of about 15 gm. barley. The yeast used was dried brewers' top-yeast. The system contained 25 ml. enzyme solution and 72·0 mgm. phytate phosphorus, as pure sodium phytate; concentration of acetate buffer, 0·2 *M*.; total volume, 100 ml.; *p*H, 5·20 ± 0·05; temp. 30° ± 0·1° C.; time of reaction 2 hr., at the end of which 10 ml. was taken out to control the *p*H and 10 ml. 5 N hydrochloric acid added to end the enzymatic reaction. Phytate phosphorus was determined in the centrifugate. When yeast was added, it was first shaken for 1 hr. with 50 ml. 0·2 M. acetate buffer and the pH readjusted before adding enzyme and substrate. The yeast extract was made by shaking 20 gm. yeast with 150 ml. 0·2 N hydrochloric acid for 2 hr. The centrifugate was neutralized with sodium hydroxide and diluted so that 10 ml. is approximately equivalent to 1 gm. yeast. 10 ml. of the extract contained 5·5 mgm. inorganic phosphorus.

INFLUENCE OF DRIED YEAST ON PHYTASE ACTIVITY

No.	Addition	Phytate P split (mgm.)	Inhibition (per cent)
1	None	41	0
2	10 gm. fresh bakers' yeast	44	10
3	30 mgm. P as pot. phosphate	37	10
4	1 gm. dried yeast	31	24
5	3 ,, ,, ,,	22	46
6	5 ,, ,, ,,	10	76
7	10 ml. yeast extract	33	20
8	30 ,, ,, ,,	24	41
9	50 ,, ,, ,,	12	71
10	No enzyme	0	—
11	No enzyme ; 3 gm. dried yeast	0	—

If the phytase activity of the fodder and of the bacteria in the intestinal canal is as highly inhibited by yeast as the above experiments seem to indicate, the results of the feeding experiments obtained in Reading may become more intelligible.

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[1] Braude, R., Kon, S. K., and White, E. G., *J. Com. Path.*, **53**, 161 (1943); **54**, 88 (1944).

Isolation of Phloridzin from Apple Seeds

IN a recent communication[1], the preparation of apple seed extracts capable of stimulating the development of unfertilized tomato ovaries was described. Treatment of the seeds with water at 100° C. for 15 minutes gave, on cooling, a crystalline substance which preliminary tests indicated was possibly glycosidic in nature. While not possessing the fructigenic activity shown by the aqueous filtrate, this compound disappeared at the stage when the extracts were no longer active, and consequently further investigation was indicated.

Hydrolysis with N/10 sulphuric acid gave glucose, characterized by the formation of the osazone and the β-penta-acetate, and a phenolic substance, m.p. 259–260° C., which gave elementary analytical results corresponding to the formula $C_{15}H_{14}O_5$. A comparison of the phenol, its tetra-acetate and trimethyl ether[2] with authentic specimens kindly supplied by Prof. A. Robertson confirmed its identity as phloretin[3] and the glucoside as phloridzin[4]. This latter is known to occur in the bark (especially the root-bark) and leaves of apple trees, but has not been reported in the seeds. In this connexion the yields are extremely interesting, being as much as 8 per cent (of seed fresh weight) four weeks after petal-fall, and decreasing to less than 1 per cent after eight weeks; ten weeks after petal-fall, phloridzin could no longer be isolated.

Further work involving an examination of the relationship (if any) between phloridzin and the hormone, and possible isolation of the latter, is proposed.

My thanks are due to Dr. L. C. Luckwill for supplying most of the glucoside and for carrying out the physiological tests.

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Dec. 4.

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[1] Luckwill, L. C., *Nature*, **158**, 663 (1946).

[2] Johnson, F. R., and Robertson, A., *J. Chem. Soc.*, 21 (1930).

[3] Fischer, E., and Nouri, O., *Ber.*, **50**, 611 (1917).

[4] Muller, A., and Robertson, A., *J. Chem. Soc.*, 1170 (1933).

Medium Suitable for the Cultivation of Meredith's Actinomycete

IN our study of the antibiotic properties of certain Actinomycetes[1], it has been one of our endeavours to devise a cheap medium for the growth of these organisms which would contain a minimum of organic and inorganic substances likely to interfere with the extraction of the antibiotic. Of the many varieties of liquid and solid media tested, we have finally adopted the following:

Autolysed yeast extract	0·25 per cent
Glucose	0·5 per cent
Distilled water	to 100 ml.

The reaction adjusted to a pH of 6·0 to 7·0.

Increasing the yeast extract content of the media beyond 0·25 per cent leads to a reduction in antibiotic production.

As for the yeast extract to be chosen, it would appear that any reasonably carefully prepared commercial brand is suitable. The three actually tried, 'Marmite', 'Gye' and 'Yeastrel', all gave the same degree of growth and antibiotic production.

Our medium has been tried also for the growth of *Actinomyces griseus*. It was found eminently suitable for this organism, yielding growth and production of antibiotic equal to that obtained by the media usually employed in the cultivation of this organism.

It may be of interest to record that the growth-liquor of our antibiotic-producing Actinomycete is highly active against a culture of *Cerospora nicotianœ* Ell. and Ev., obtained from the Baarn Type Culture Collection, and claimed to be responsible for the spotting of the tobacco leaf.

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Dec. 5.

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[1] Thaysen and Butlin, *Nature*, **156**, 781 (1945).

Connective Tissue Cementing Substance

IN 1876, W. Flemming[1] described a cementing substance associated with the fibrils of loose connective tissue. This finding is of considerable importance in relation to modern conceptions of the chemical structure of collagen and other fibrous proteins.

There is reason to suppose that the long-chain molecules of which collagen fibres are composed are mainly held together by lateral bondings of an electrovalent character. It has been pointed out by the late Dr. Jordan Lloyd[2] that, since such bondings are readily

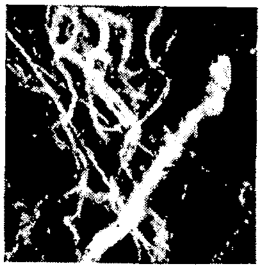

Fig. 1

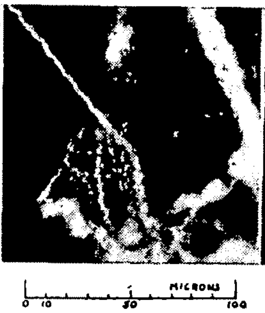

Fig. 2

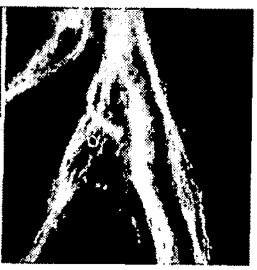

Fig. 3

Fig. 1. DARK GROUND PREPARATION SHOWING THE COMPACT BUNDLES OF COLLAGEN FIBRILS IN DISTILLED WATER AT pH 7·0. AN ELASTIC FIBRE MAY ALSO BE SEEN RUNNING DOWNWARDS AND DIAGONALLY FROM THE LEFT UPPER CORNER OF THE PHOTOGRAPH

Fig. 2. COLLAGEN BUNDLES AT pH 3·8. THEY ARE NARROW AND MARKEDLY CRIMPED

Fig. 3. COLLAGEN BUNDLES IN $M/2$ CONCENTRATION OF SODIUM CHLORIDE. THE BUNDLES ARE WIDE AND STRAIGHT AND THEIR CONSTITUENT FIBRILS EASY TO IDENTIFY. IN SUCH CONCENTRATIONS OF NEUTRAL SALTS THE INDIVIDUAL FIBRILS FREQUENTLY SHOW BROWNIAN MOVEMENT

susceptible to ionic penetration, it is somewhat surprising that when collagen bundles are removed from the animal body and teased out in water they show no tendency to dissolve but remain as coherent structures for a considerable time. Dr. Jordan Lloyd suggested that the larger collagen bundles are held together by sheaths composed of another fibrous protein, the reticular tissue. Specialized sheaths of this kind may certainly be shown to surround relatively large collagenous structures such as the tendons in the tail of the rat; but it is difficult to visualize such an arrangement in the much smaller bundles of loose connective tissue which in small animals vary from 2 to 10 μ in diameter. My observations of the loose connective tissue of the rat furnish strong evidence that these smaller bundles owe their cohesion to the presence of an amorphous cementing substance within them, rather than to any sort of fibrillary wrapping.

After killing the animal, pieces of fascial connective tissue were placed directly into the fluid the effect of which was to be investigated. After half an hour at room temperature, they were mounted under a coverslip in the same fluid and examined with the dark-ground microscope. In distilled water, pH 7·0, the bundles of collagen fibrils appeared compact. Their constituent fibrils were not generally easy to identify. With increase in hydrogen ion concentration the bundles became more condensed, their optical opacity was greatly increased, there was great reduction in thickness, and they became coiled up and crimped. This effect was easily perceptible at pH 5·0. It was maximal between pH 4·2 and 3·8. With further increase in hydrogen ion concentration, acid swelling of the collagen began, and at pH values between 3·8 and 3·0 the appearances indicated the antagonistic action of two processes, namely, the contraction of the cementing substance and the swelling of the collagen. The irregular beaded swellings of collagen bundles in acids of strengths around 0·001 N would seem to be a resultant of these two antagonistic processes.

An effect contrary to that due to hydrogen ions was produced by neutral salts. Concentrations of, and greater than, $M/8$ caused relaxation of the substance cementing the fibrils together. The bundles became wide and straight, and their constituent fibrils could readily be identified. In some bundles the individual fibrils were seen to show Brownian movement.

The contrasted changes produced in the cementing substance by hydrogen ions on one hand and neutral salts on the other were found to be reversible up to the point at which acid-swelling of collagen occurred. Bundles swollen in acid became shrunken again after treatment with salt, but they did not recover their former fibrillary structure. They remained opaque and granular.

Fleming considered the cementing substance to be of mucinous nature. This was not confirmed. On the contrary, pieces of connective tissue treated with testicular extract and also pieces treated with purified streptococcal hyaluronidase did not lose the properties described above. Treatment with a phosphate buffer of pH 8·0 at 0° C. for several days failed to remove the cementing substance. There is strong evidence, however, that this substance is acted upon by trypsin. After immersion in a solution of trypsin for 24 hours at 20° C., connective tissue loses its coherence and elasticity. It may be teased apart like a piece of damp blotting paper. In pieces afterwards treated with fluids of appropriate hydrogen ion concentration and examined with the dark-ground microscope, the crimping of the bundles is markedly reduced or entirely absent.

The presence of cementing substance within the bundles has been particularly emphasized. Its existence outside the bundles is harder to demonstrate, but may be reasonably deduced from the fact that at hydrogen ion concentrations around pH 4·0 the connective tissue as a whole becomes opaque and that opaque granules appear outside the fibrils.

It is to be concluded that the collagenous bundles of loose connective tissue owe their cohesion largely to a cementing substance in which their constituent fibrils are embedded. This substance is a protein, since it is acted upon by trypsin. Its viscosity would appear to be progressively increased in concentrations of hydrogen ions ranging from neutrality to pH 3·8, and reduced in the presence of neutral salts in concentrations of, and above, $M/8$.

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[1] *Arch. mikr. Anat.*, 12, 442 (1876).

[2] *J. Soc. Dyers and Col.*, 57, 281 (1941).

Epidermal Thickness Following Oestrone Injections in the Mouse

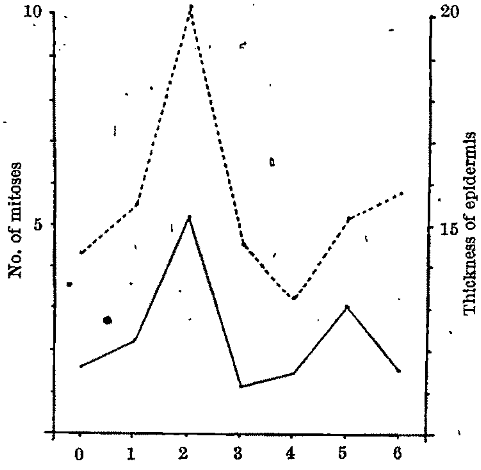
THE cyclic variation in the mitotic activity of the epidermis of the adult female mouse, which is dependent on the cyclic activity of the ovary, is accompanied by coincident cyclic variation in epidermal thickness[1]. Thus, in the antero-dorsal region of the body, the highest rate of mitotic activity occurs during the pro-œstrous period, with the result that the epidermis is at its thickest in pro-œstrus and early œstrus. It has also been shown that the mitotic activity of the epidermis can be artificially stimulated by œstrone injections[2], and it would therefore seem probable that the same treatment would result in epidermal thickening. However, Hooker and Pfeiffer[3] have reported that injections of œstradiol benzoate result in a decrease of epidermal thickness, an effect apparently due to inhibited mitotic activity. An additional analysis of the effects of œstrone injections on the rate of cell division and thickness of the epidermis has therefore been made in an attempt to throw light on the apparent contradiction.

The injections were started on the first day of diœstrus, the time when both the mitotic activity and the thickness of the epidermis are at a minimum. At each injection 0·025 mgm. of œstrone in 0·25 c.c. of water was introduced into each mouse, and the injections were repeated at 12-hourly intervals for three days. Groups of five mice each were killed 12 hours after receiving from one to six injections, and each animal was also given 0·1 mgm. of colchicine $9\frac{1}{2}$ hours before killing. The mitoses, mostly in the metaphase, were counted in 1 mm. lengths of anterodorsal epidermis cut at a thickness of 7 µ. Twenty counts were made for each individual, and thus for each group there were 100 counts, from which averages and standard deviations were calculated. In the same way the results regarding epidermal thickness summarize 100 measurements per group, the distance measured being from the base of the stratum germinativum to the free surface of the stratum corneum.

The results are recorded in the accompanying table and illustrated in the graph. From them it is evident that the induced mitotic activity was accompanied by an increase in epidermal thickness, the two maxima being reached simultaneously after two injections. Rapid cornification, combined with sloughing, apparently accounted for the fact that the thickness did not remain considerable after the rate of mitosis fell.

While these experiments lasted only three days, those of Hooker and Pfeiffer continued for a long period, the injections being given twice weekly. A comparison of the results indicates that although the mitotic activity and thickness of the epidermis are normally increased by œstrogenic substances, a prolonged excess of such substances leads to the opposite effect. The same is true of the sebaceous glands. Their mitotic activity and growth are normally stimulated by œstrogens[2]; but if the stimulation is unduly great and unnaturally prolonged, the opposite effect is produced[3]. Further, although the growth of hair presents special problems, it is interesting to note that here again the mitotic activity of the hair bulb is reduced by the continued administration of œstrogenic substances.

	Numbers of mitoses per mm. of epidermis	Thickness of epidermis (in µ)
Diœstrus: 1st day	1·65 ± 1·13	14·4 ± 4·2
Œstrone injections:		
1	2·26 ± 2·12	15·5 ± 2·99
2	5·12 ± 3·63	20·2 ± 4·37
3	1·14 ± 1·45	14·5 ± 1·94
4	1·41 ± 1·43	13·2 ± 2·59
5	3·02 ± 2·76	15·3 ± 2·51
6	1·64 ± 1·60	15·8 ± 4·13



RELATION BETWEEN MITOTIC ACTIVITY (CONTINUOUS LINE) AND THICKNESS (BROKEN LINE) OF MOUSE EPIDERMIS FOLLOWING ŒSTRONE INJECTIONS

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Dec. 6.

[1] Bullough, H. F., *J. Endocrin.*, 3, 280 (1943).

[2] Bullough, W. S., *Phil. Trans. Roy. Soc.*, B, 231, 453 (1946).

[3] Hooker, C. W., and Pfeiffer, C. A., *Endocrin.*, 32, 69 (1943).

Soil Sterilization on a Field-Scale

THE steam sterilization of soils is well known; for example, as carried out under glass for tomato growing—a practice which is now accepted as routine. As well as achieving a drastic diminution in the numbers of harmful bacteria, to the advantage of the surviving nitrifying bacteria, there is a marked increase in available nitrogen.

In the spring of this year, 'Gammexane' was mixed with fertilizer and sown with oats through a combine seed drill; this was on old lea with negligible wireworm and leatherjacket counts. The treated area revealed stronger, broader-leaved plants, and of a depth of green which made the control look undernourished. This difference was apparent until the oats were fully a foot long.

The same compound was applied on 'brairded' swedes, but this time for the purpose of mitigating the ravages of the turnip flea beetle; on this crop the 'Gammexane' was sown broadcast. The effect was very similar to that on the oats, namely, greater depth of colour and more vigorous plants. It is of interest to note that the weeds between the drills were also more vigorous than in the rest of the field.

From these observations, one may be justified in assuming that the chlorine liberated from the 'Gammexane' has effected a partial sterilization of the soil, and in consequence an increase in available nitrogen.

This opens up a field for wider investigation and research, and it is possible that in compounds of this nature we have, not only an insecticide of the first order, but also a sterilizing agent, easily handled and with unlimited possibilities within the industry.

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COMMONWEALTH OF AUSTRALIA COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT

THE nineteenth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia, covers the year ended June 30, 1945, and indicates the greater attention which was given to problems of post-war reconstruction, as, for example, in the use of the Soils Division's surveys of areas intended for closer settlement (Canberra: Commonwealth Gov. Printer). The report also refers for the first time to the Division of Radiophysics, which with its central laboratory at the University of Sydney was formed early in the War, and until the termination of hostilities was engaged solely on work for the Australian and American Fighting Services. In addition to representatives of the Australian Fighting Services, the Radiophysics Advisory Board included representatives of the Postmaster-General's Department and, later, of the Ministry of Munitions, while effective liaison was also established with Great Britain and the United States through the British Central Scientific Office at Washington. In addition to assisting the Services very considerably in technical training courses and facilities, the Division has been engaged in fundamental research associated with the design of radar equipment and in the investigation, development, design and manufacture to the prototype stage of radar and associated equipment required by the Armed Forces. A light-weight radar set was designed and constructed for the Royal Australian Air Force for air warning purposes, and in addition to investigations into the cause and incidence of super-refraction at relatively low heights in the atmosphere and ionospheric observations, the Laboratory has now initiated some work on possible applications in the field of navigational aids for civil aviation.

In addition to the account of the formation and work of this new Division, the report refers also to the conversion of three sections of the National Standards Laboratory to the status of Divisions of Metrology, of Electrotechnology and of Physics, respectively, while the former Division of Animal Health and Nutrition has been separated into two divisions, known as the Division of Animal Health and Production and the Division of Biochemistry and General Nutrition.

An important development during the year was the decision to undertake a comprehensive programme of research into building materials, including concrete and other materials for structures such as bridges, dams, etc. The Council has also accepted responsibility for work on flax processing, and is to be entrusted with an extensive programme of research and publicity for the wool industry; while as from April 16, 1945, the Council has taken over the Scientific Liaison Bureau.

Under the Division of Plant Industry, a laboratory for the study of pasture production under irrigation is being established in the area between the Murray and the Murrumbidgee Rivers, while other pasture investigations were concerned with pasture management, soil fertility, the establishment of pasture under cover crop, the control of Capeweed and other weeds. The Division also conducted trials of plants and seeds introduced from abroad, forage and pasture plant trials, as well as investigations on Guayule rubber, take-all disease of wheat, native plants as sources of medicinal drugs and insecticidal substances, the opium alkaloids, tobacco, the potato virus and varietal resistance to leaf roll, spotted wilt and fusarium wilt of tomato, the retting of flax, etc. Investigations on the physiological diseases of apples and pears were on a much reduced scale; but in the entomological field the outstanding feature was the attention given to the new insecticides D.D.T. and 666. A large-scale programme of investigation on the use of D.D.T. for the control of agricultural and horticultural pests was carried out in co-operation with all the State Departments of Agriculture, and particularly promising results were obtained in the control of cattle tick, buffalo fly and certain household pests. Methods for the control of mosquitoes and house flies reached an advanced stage of development, and investigation of the pests of stored wheat was practically concluded with the development of effective measures for the control of infestations in the main types of temporary stores. Much success in particular attended the campaign, based on the Council's advice, against wheat weevil carried out by the Australian Wheat Board; while the work on the biological control of weeds and insect pests continued to show great promise; for example, that of St. John's wort by three species of *Hypericum* insects. Work on D.D.T. emulsions led to the development of a solvent naphtha emulsion which was used in field trials in 1944–45, mainly at 0·2 per cent D.D.T., and work on the control of cattle ticks included trials with D.D.T. sprays.

Animal health investigations covered pleuropneumonia of cattle, mastitis in dairy cattle, contagious abortion of cattle, and the bacterial oxidation of arsenic cattle-dipping fluids. Studies with phenothiazine continued, as well as investigations of the blowfly strike problem and biochemical studies on mineral metabolism of sheep. There was no break in the sequence of the long-term research projects concerned with the nutrition of the Merino sheep, and the results should now provide a rational basis for breeding policy. Drought feeding and metabolic studies, the supply of vitamin A to flocks during prolonged periods of drought, the study of the plant proteins which are the raw materials from which the sheep produces wool fleece, studies of minor element deficiencies, and especially copper deficiency, are other directions in which the Council is assisting this major Australian industry.

The Division of Soils continued with a wide programme of surveys and investigations, and the obstacle to rapid progress presented by the lack of experienced staff is now being removed by the training of new personnel. Field-work was turning increasingly to the relation of soils and land use. The Soil Chemistry Section, organised jointly with the Chemistry Department of the Waite Institute under single direction, devoted attention to the study of methods for the examination of soils, including the use of the Lundegårdh flame spectrum technique for the determination of exchangeable cations. The study of soil structure and water relations of soils formed the main activity of the Soil Physics and Mechanics Section, while in the Bacteriology Section the investigation of the nitrogen-fixing organisms of leguminous plants was the main line of research.

At the Commonwealth Research Station, Merbein, initial investigations on vegetable production were completed, particularly variety trials of tomatoes, beans and carrots, while at the Irrigation Research Station, Griffith, work on the best methods of irrigation of both orchard and vegetable crops continued. Much of the work of the Division of Forest Products was again associated with the war effort; but the need for a more concentrated examination of timber utilization in Australia is recognized, and a series of lectures was prepared for a reconstruction training course for Service personnel proposing to enter the building trade. Wood structure, timber physics and mechanics, timber preservation and seasoning continued to receive attention, as well as the improvement of wood, particularly by gluing or impregnation with dimethylolurea.

The Food Preservation Division is to resume its investigations on the preparation and storage of chilled beef with particular attention to the loss of bloom, and work is also to be started on the rapid freezing of fruit and vegetables. Fundamental aspects of the metabolism of ripening and senescence of fruits were examined at the University of Sydney. Apparatus was designed for measuring the vapour pressure of dried foods, and heat transfer and evaporation from a wet surface under still air conditions; investigations on *Clostridium botulinium* and on the resistance of this and other bacterial spores to heat were continued. The relation between mould growth and the activity of water in fruit cake, the development of ascorbic acid in processed foods on prolonged storage and fundamental studies on the oxidation of ascorbic acid in fruit and vegetable tissue suspensions were initiated. The Division of Fisheries was able to expand its work somewhat.

The Division of Metrology continued to assist production directorates of the Ministry of Munitions and industrial organisations concerned with defence, in matters relating to inspection, design and examination of gauges, measuring equipment and precision tool-room equipment. The Division of Electrotechnology concentrated largely on confidential defence investigations, but is now considering the resumption of normal work. Its future programme is likely to be influenced by the recent formation of an Electrical Research Board. The programme of research on tropic proofing and the scope of climatic and durability tests on telecommunication materials and communications have been considerably extended. The Physics Division is also planning to extend its long-range and fundamental research; among work carried out during 1944–45 were studies of the optimum visual conditions for radar operators, the photometry of a new type of searchlight, the control and measurement of humidity in connexion with tropic proofing of service equipment, the design of an instrument for the accurate and rapid measurement of hæmoglobin for 'blood bank' work, and fundamental work on the physics of wool fibres. Aeronautical investigations have included studies of the effects of turbulence on the size, state and stability of the boundary layer formed on the surface of solid bodies moving through air, the strength and stability of plywood construction, a mathematical study of the vibration characteristics of an engine-propeller – cooling-fan combination, powder metallurgy, welding of steel tubing and fatigue failures.

In the Division of Industrial Chemistry, a Section of Chemical Physics has been established at Melbourne. The Minerals Utilization Section has perfected a method for the production of the special grade of rare-earth oxides required for polishing optical lenses and prisms. The Cement Section is investigating the deterioration of concrete through expansive reaction between aggregates and cement, and in the Biochemistry Section the development of depilatory paints less harmful to wool than the lime-sulphide paint now used, the wool-loosening action of ammonia, proteolytic enzymes and the production of 2 : 3-butylene glycol by fermentation have received attention. The separation of minerals by flotation, physico-chemical characteristics of acridine drugs and surface areas of solids have been studied by the Physical Chemistry Section. The Organic Chemistry Section was also concerned with the production of butadiene from 2 : 3-butylene glycol obtained by fermentation, and continued work on the exudation of mannitol from *Myoporum platycarpum*, synthetic resin adhesives and aniline-formaldehyde resins. In the Chemical Engineering Section pilot-plant trials were conducted of the Fremey-Lipson process rendering woollen goods resistant to felt, and of an improved process for the manufacture of rare-earth hydroxides from monazite. The general basic attack on problems associated with friction, lubrication, bearings and wear continued, including the mechanism of boundary lubrication, effect of abrasives on wear, the development of a soluble extreme-pressure cutting and drawing lubricant, the lubrication between a journal and a bearing and the behaviour of pure metals.

THE GEOMETRY OF NUMBERS

THE meeting of the London Mathematical Society on December 19, 1946, took the form of a symposium on the geometry of numbers, arranged by Prof. H. Davenport. Prof. E. C. Titchmarsh, president of the Society, was in the chair.

In his introductory remarks, Prof. Davenport outlined the nature of the subject. It consists in interpreting geometrically questions in the theory of numbers, making use of points with integral co-ordinates, either in the plane, or, more generally, in an n-dimensional space. The system of all points with integral co-ordinates is called the *standard lattice*. The general homogeneous linear transformation, or affine transformation, of the standard lattice gives a *general lattice*. Thus the points of a general lattice in n-dimensional space are the points $(x_1, \dots, x_n)$, where $x_1, \dots, x_n$ are linear forms:

$$\begin{array}{l} x_1 = a_{11} u_1 + \dots + a_{1n} u_n \\ \dots\dots\dots\dots\dots\dots\dots\dots \\ x_n = a_{n1} u_1 + \dots + a_{nn} u_n \end{array}$$

in n variables $u_1, \dots, u_n$, which take all integral values. The determinant of the coefficients a_{ij} is called the determinant of the lattice, and measures the density with which the lattice points are distributed in space (the density being inversely proportional to the determinant).

Many questions in the theory of numbers can be expressed in the form: Does a particular region contain a lattice point, or under what conditions is this the case? This geometrical approach led Minkowski to many important theorems. It is also valuable in suggesting new and interesting questions, even when it does not provide any means for answering them. Two of the three topics discussed later are, in fact, treated by other methods.

Mr. C. A. Rogers spoke on his recent work[1] on a theorem of Hlawka. This theorem is a partial converse of the fundamental theorem of Minkowski, which asserts that any convex body in n-dimensional space, which is symmetrical about the origin of co-ordinates O, and has volume greater than 2^n, contains a point other than O of every lattice of determinant 1. Hlawka's theorem, in its most fundamental form, states that if any body (whether convex or not) has volume less than 1, then there exists a lattice of determinant 1 such that no lattice point, except possibly[1] O, lies in the body. Mr. Rogers gave a simple proof of this theorem, restricting himself to the two-dimensional case for simplicity. We are given a bounded region in the plane, of area A less than 1. Let p be a large prime, and consider the lattice of points (x, y) with

$$x = u/\sqrt{p}, \quad y = (su + pv)/\sqrt{p},$$

where s is fixed, and u, v take all integral values. This lattice has determinant 1. We give s the values $0, 1, \ldots, p - 1$, and suppose that each of the lattices has a point other than O in the region. It can be proved that these p points are all different. On the other hand, the total number of points of all the lattices in the region is easily found to be asymptotically pA for large p. Since $A < 1$, this is impossible, and so one at least of the lattices satisfies the requirement of having no point, except possibly O, in the region.

Dr. H. Heilbronn spoke about some recent joint work with Prof. Davenport on a problem to which they had been led by considerations in the geometry of numbers. The problem was to find two lattice points in a given plane lattice, say (X_1, Y_1) and (X_2, Y_2), which generate the lattice, and for which $X_1 Y_2$ is numerically small. Two such points would be, in a certain sense, each near one of the two coordinate axes. Expressed analytically, the problem becomes that of investigating the minimum of a bilinear form:

$$B = (\alpha x + \beta y)(\gamma z + \delta t),$$

when x, y, z, t take all integral values which satisfy the condition $xt - yz = \pm 1$. The results are as follows[2]. If $\Delta = |\alpha\delta - \beta\gamma|$, one can always satisfy $|B| \leqslant 2\Delta/(5+3\sqrt{5})$. If certain special forms are excluded (namely, those equivalent to $(x + \theta y)(z + \theta' t)$, where θ and θ' are $\frac{1}{2}(-1 \pm \sqrt{5})$), this can be improved to $|B| \leqslant \Delta/(4+2\sqrt{2})$. If more special forms are excluded, this can be further improved to $|B| \leqslant \Delta/(3 + 3\sqrt{2})$. But this inequality cannot be further improved by similar exclusions. There is a striking contrast with Markoff's results on the minimum of an indefinite quadratic form $(\alpha x + \beta y)(\gamma x + \delta y)$. There Markoff established the existence of an infinite sequence of possible minima. In the present problem, the first two possible minima of the bilinear form correspond to those of a quadratic form, but the third does not.

Prof. Davenport gave the third talk, which was on another joint paper[3] with Dr. Heilbronn. Let $Q(u_1, \ldots, u_r)$ be an indefinite quadratic form in r variables. It has been conjectured for many years that if $r \geqslant 5$, such a form takes arbitrarily small values for an infinity of integral values of the variables. If the form has rational coefficients, this is true, since it then represents zero infinitely often. The general conjecture has an interpretation in the geometry of numbers. It is that the region of r dimensional space defined by

$$|x_1^2 - x_2^2 \pm x_3^2 \pm \ldots \pm x_r^2| < 1,$$

where $r \geqslant 5$, contains a point other than O of *every* lattice. In the language of Mahler, this region is of 'infinite type'.

A special case of the conjecture was proved by Chowla in 1934, namely, when $Q = \lambda_1 u_1^2 + \ldots + \lambda_r u_r^2$ and when $r \geqslant 9$. In the present work the result is proved for this particular form when $r \geqslant 5$. The proof uses a modification of the powerful methods created by Hardy and Littlewood for the treatment of problems in additive number-theory.

Prof. L. J. Mordell expressed appreciation of the talks, and said that the work of Mr. Rogers was particularly interesting in view of the complication of Hlawka's original proof, and of the deep ideas associated with the theorem by Siegel, in his recent proof in the *Annals of Mathematics*. Mr. Rogers had shown the value of a new and elementary approach to an apparently difficult theorem.

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[1] *Ann. Math.*, in the press.

[2] *Quart. J. Math.*, in the press.

[3] *J. London Math. Soc.*, in the press.

COMPLETE DOCUMENTATION*

By Dr. S. C. BRADFORD

THIS Conference is important historically, because it marks the beginning of a second stage in the progress of documentation. In the past, our main endeavour has been directed to bring about the collaboration of documentary agencies in the single task of making accessible the scattered records of thought and achievement, especially in science and technology, until to-day more decimally classified references are produced than different papers abstracted. But, as the result of statistical investigations, made in the main by the British National Section, we have come to see that this alone will not suffice to produce a tolerably complete index to the records of human endeavour. Half the records are overlooked by the existing abstracting and indexing agencies. We need a means of covering all this literature. The means has been discovered. Its promotion has commenced, and this begins a second stage in our activities.

Statistical analyses have been made of the whole intake of the Science Library, London, not merely of three per cent samples. The results are for that reason the more reliable, although there is still room for more research, for which financial aid would be desirable.

The investigations were divided into four parts: (i) It was established that about ¾ million useful scientific and technical papers are recorded every year in an aggregate of some 15,000 useful scientific periodicals, while 300 abstracting and indexing periodicals publish also ¾ million abstracts, or references. But these abstracts, or references, relate to only ¼ million different papers. So that more than half the useful discoveries and inventions are recorded, only to be buried on the library shelves.

(ii) This general analysis was confirmed by the examination of the literature of certain definite subjects. The details of the examination of electrical engineering literature show that only 11,500 different papers on this subject, out of an annual output of 24,000, are covered by a yearly total of 45,000

* Synopsis of a paper read at the sixteenth International Conference of the International Federation for Documentation at Paris, November 4–9, 1946.

abstracts, or references. These tests indicated also the basic reasons for this imperfection, which are: (a) individual abstracting agencies concentrate upon the periodicals devoted to their special subjects, together with a few of those the fields of which are closely allied to these subjects, and thus they miss the articles on their special subjects which occur in other periodicals the scopes of which are less closely related to them; and (b) abstracting agencies often ignore books, pamphlets, separate reports and patent specifications.

(iii) The actual scattering of articles on a given subject throughout the mass of periodical literature was investigated. This scattering is the necessary consequence of the fact that every branch of science is related in some degree to every other branch of science, so that a periodical on any branch of science may contain, from time to time, a paper which is of interest from the point of view of any other science. The actual law of scattering has been deduced, both from theoretical consideration, and from investigation of the actual articles indexed on a given subject. This law shows that it is practically impossible for an abstracting agency, acting alone, to pick up more than about half the articles published on its special subject.

(iv) The actual occurrence of these scattered articles, in the estimated quantity, was proved by a bulk experiment with the collaboration of the abstractors of a large abstracting bureau.

These experiments show conclusively that, somehow, every useful article in every useful periodical must be dealt with as it appears. There are two different ways of accomplishing this task. Either we could create a new organisation to index, or to abstract, each useful article in each useful periodical, independently of the subject of the article; or the useful periodicals could be divided into groups, according to the subjects treated by existing abstracting agencies, and these agencies should undertake to pass on the articles not within their scopes to the agencies who should be interested in their subjects.

The former method would be utterly uneconomic, because it would duplicate, without any adequate reason, the work of the existing skilled and experienced abstracting bureaux. The latter method needs much less additional expense. No interference is involved with the internal machinery of any abstracting agency. Each can continue to deal with and abstract as many periodicals as it desires and to publish its abstracts in any format, provided only that it passes on the articles not within its own scope.

The application of this principle has been commenced in Great Britain. A committee of important abstracting agencies has been formed, which has accepted the principle, and an agreement has been made by two of the most important agencies, British Abstracts and Science Abstracts, to work together so far as possible in this way. Bibliography is unforgettably indebted to Dr. J. A. Wilcken, secretary of the British Committee, for his outstanding services in this work.

The comprehensive indexing of books and other separate publications is essentially a matter for librarians and can best be achieved by improving the accessions lists of the national libraries of each country. In this way we can certainly achieve complete documentation.

[This plan was adopted unanimously by the Council of the International Federation for Documentation, and a small international committee was appointed to promote it.]

SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING

THE forty-fourth annual meeting of the Science Masters' Association was held at the Imperial College of Science and Technology, London, during January 1–3; and once again, in spite of the fact that the previous meeting was held only last Easter, the attendance was large, and an excellent programme of lectures and visits to works marked another successful gathering. There was also the usual exhibition of books and apparatus by the leading publishers and manufacturers of scientific apparatus, and the customary exhibit of apparatus devised and constructed by members themselves, and also one of graphic material of use in teaching. The Association has now returned to its old practice of holding its annual meeting during the Christmas holiday.

Giving the presidential address, Lord Horder spoke on the "Place of Science in Teaching", approaching this in the free and interesting spirit of one who saw things in their wider setting, and presenting some sound advice to his audience. His address, which sparkled at times with some keen wit and was illustrated by apposite anecdote, took three aspects of the subject: the pupil, the matter taught, and the teacher. The most important aspect is the pupil, who is still, it must be emphasized, a child, still half-savage, with recurring moods of self-exhibitionism and fantasy which can last well into undergraduate life and which must neither be unduly encouraged nor neglected. The task of the teacher is to help the child on the road to the full development of personality; he cannot create such personality.

The matter taught must be free from domination by the examination spectre which stultifies curiosity and impairs receptive power, and must avoid undue emphasis on application at the expense of first principles. Through the study of science the youthful mind can acquire habits of clear thinking and direct expression which lead it to become a joy to itself and a source of benefit to others.

The attitude of the teacher is of fundamental importance to the efficiency of his teaching. This attitude must be animated by two ideals: first, that science must be free and self-contained, owing subservience to neither Church, State nor the pressure of economic adjustment; secondly, the discoveries of science must be used for the benefit of humanity. The present troubles of the world are due to too little science, not too much. To drive science underground by the cessation of research would be to repeat all the evils of the Dark Ages. What is important is that we retain sufficient control to drive the machine and not allow it to drive us. Upon these ideals it is important that science teachers should stand firm. The chief aim of science is truth, and truth grows as does a living plant, which suffers as much from forcing as it does from neglect.

The Association was again fortunate in having lectures from men of science of eminence in their own fields. Mr. E. J. Bowen spoke on "Elementary Wave-Mechanics", presenting a treatment which opened the way to deriving ideas of great value in chemistry teaching; Sir Edward Salisbury discussed "The Changing Flora of Britain", describing the nature of large-scale changes since the Glacial period; Sir George Thomson spoke on "Atomic Energy in Peace and War", ending with a stimulating consideration of present problems; Prof. J. Z. Young took the subject of "Use, Effort and the Powers of Life", and dealt with the problem of treating in biology the self-preserving powers of organisms; and Dr. G. A. Jones discussed "High Speed Cinematography", accompanying his lecture with demonstrations of modern devices used to synchronize flash and exposure.

At the business meeting of the Association it was announced that the Association had been invited to hold its next annual meeting at the University of Sheffield. Prof. Irvine Masson, vice-chancellor of the University of Sheffield, has consented to serve as president for this year. Prof. E. N. da C. Andrade, last year's president, was elected an honorary member according to custom, and this tribute was also paid to the work for the Association of Mr. F. Fairbrother, the retiring membership secretary. Mr. H. F. Broad (Leighton Buzzard) was elected membership secretary in succession to Mr. Fairbrother; and in succession to Mr. A. E. E. McKenzie (chairman) and Mr. E. Lucas, who retired from the Committee, the meeting elected Mr. J. Lambert (King Edward School, Birmingham) and Mr. H. Jennings (Liverpool College). Mr. E. H. Coulson was re-elected treasurer.

A. E. Bell

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, January 20

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. J. M. Meek: "Lightning and Spark Discharges".*

Royal Anthropological Institute (joint meeting with the Royal Geographical Society, at Kensington Gore, London, S.W.7), at 5.30 p.m.—"The Ashanti Social Survey, 1945–46".

King's College, Strand, London, W.C.2, at 6 p.m.—Prof. S. J. Davies: "Gas Turbines and their Prospects" (Lecture on behalf of the Institute of Marine Engineers).*

Tuesday, January 21

Society of Chemical Industry, Agriculture Group (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. F. H. Malpress: "The Use of Hormones in Animal Husbandry".

Society of Dyers and Colourists, Leeds Junior Branch (in the Colour Chemistry and Dyeing Department, The University, Leeds), at 4 p.m.—Dr. F. H. S. Curd: "The Chemotherapy of Malaria".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. C. D. Darlington, F.R.S.: "The Physiology of Chromosomes". (Subsequent lectures on January 28 and February 4.)

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Symposium on "Relation of Intelligence to Fertility" (Speakers: Sir Alexander Carr Saunders, Sir Cyril Burt and Dr. J. H. Fraser Roberts).

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Radio versus Line for Communication Systems" (to be opened by Mr. A. H. Mumford).

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 6.30 p.m.—Annual General Meeting.

Society of Dyers and Colourists, Huddersfield Section (at Field's Café, Huddersfield), at 7.30 p.m.—Dr. T. Richardson and Mr. E. R. Wiltshire: "The Package Dyeing of Cotton by the Pigment Method".

Institute of Physics, Scottish Branch (at the University, Edinburgh).—Prof. P. I. Dee, F.R.S.: "Photography of Atomic Tracks".

Wednesday, January 22

Institution of Post Office Electrical Engineers (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E.C.4), at 5 p.m.—Mr. A. Hudson, Mr. E. A. Smith and Mr. F. S. Hyatt: "Auto. Exchange Maintenance".

Physical Society, Low-Temperature Group (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. M. Ruhemann: "The Separation of Oil Gases".

Royal Meteorological Society (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Annual General Meeting; Mr. G. Manley: "The Geographer's Contribution to Meteorology".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Sir Claude Gibb: "Gas Turbines".

Institution of Electrical Engineers (joint meeting of the Transmission and Measurements Sections, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Switchgear Alarms and Indications" (to be opened by Mr. T. S. Andrew and Mr. T. R. Reyner).

Society of Dyers and Colourists, Midlands Section (at the Victoria Hotel, Nottingham), at 7 p.m.—Mr. C. S. Turner: "Shortcomings of the Dyeing Industry as seen by the Launderer, Dry-cleaner and Garment Dyer".

Thursday, January 23

Chemical Society, Liverpool Section (in the Chemistry Lecture Theatre, The University, Liverpool), at 5 p.m.—Prof. H. A. Krebs: "Metabolic Cycles".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Major Gavin Maxwell; "The Basking Shark (*Cetorhinus maximus*) of the Hebrides"; Dr. Hans Grüneberg: "The Significance of Coat Colour in Mammals".

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. W. Melville, F.R.S.: "The Chemistry of High Polymers". (Subsequent lectures on January 30 and February 6.)

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Discussion on "Statistics and the Statistician in Industry" (to be opened by Mr. H. T. Weeks).

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. V. J. Francis and Mr. W. R. Stevens: "The High-Pressure Mercury-Vapour Discharge and its Applications".

Chemical Society, South Wales Section (joint meeting with the University College of Swansea Chemical Society, in the Chemistry Lecture Theatre, University College, Swansea), at 6 p.m.—Mr. E. J. Bowen, F.R.S.: "The Absorption of Light".

Royal Institute of Chemistry, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Prof. T. P. Hilditch, F.R.S.: "Fat Shortages and Fat Substitutes".

Chemical Society, Society of Chemical Industry and Royal Institute of Chemistry, Edinburgh and East of Scotland Sections (at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Mr. F. A. Scholefield: "Edmund Knecht" (Society of Chemical Industry Jubilee Memorial Lecture).

Friday, January 24

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Atmospheric Oscillations" (to be opened by Prof. S. Chapman, F.R.S.).

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. Cobden Turner and Mr. G. M. Tomlin: "The Application of Electrical Technique to the Service of some other Industries".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. F. T. Barwell and Mr. J. C. W. Humphrey: "Materials New to Engineering".

Society of Dyers and Colourists, Scottish Section (at St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. G. G. Simpson: "The Selection of Dyes for Covering Faded Garments".

Chemical Society, Aberdeen Section (in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Dr. D. P. Cuthbertson: "Recent Advances in our Knowledge of the Metabolism of Proteins and Amino Acids".

Saturday, January 25

Biochemical Society (at the British Postgraduate Medical School, Ducane Road, London, W.12), at 11 a.m.—Scientific Papers and Demonstrations.

British Sound Recording Association (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 4.15 p.m.—Conference on "Sound Recording".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Graduate Field Research Workers to investigate problems connected with the growth of forest trees in relation to soil and site factors—The Director, Imperial Forestry Institute, The University, Oxford (January 25).

Lecturer in the Department of Mechanical Engineering—The Principal, Birmingham Central Technical College, Suffolk Street, Birmingham (January 25).

Lecturer in Chemistry, and a Lecturer to teach Electrical and/or Civil and Mechanical Engineering, in the Plymouth and Devonport Technical College—The Director of Education, Cobourg Street, Plymouth (January 25).

Assistant Teacher to be responsible for Agricultural Science, Animal and Soil Husbandry—The Chief Education Officer, County Offices, Aylesbury, Bucks. (January 29).

Lecturer in Mechanical and Electrical Engineering in the Mining Department of the Denbighshire Technical College, Wrexham—The Director of Education, Education Offices, Ruthin (January 31).

Assistant Masters in H.M. Dockyard Schools—The Director, Education Department, Admiralty, London, S.W.1 (January 31).

Technician for research laboratory workshop—The Secretary, Barnato Joel Laboratories, Middlesex Hospital, London, W.1 (February 1).

Chemists (men and women, temporary) at various research and development establishments of the Ministry of Supply—The Secretary, Ministry of Supply (Est.5.B.2), Room 828, Adelphi, London, W.C.2, quoting 'Chem/Gen' (February 1).

Lecturer in Social Anthropology—The Registrar, The University, Oxford (February 7).

Assistant Lecturer (Grade III) in the Department of Biochemistry—The Registrar, The University, Liverpool (February 7).

Economist (with a good degree and experience of economic research), and a **Sociologist** (with a good degree and experience of sociological or anthropological research), in connexion with a survey of factors bearing on the problem of nutrition in the Gambia—The Secretary, Colonial Social Science Research Council, Palace Chambers, Bridge Street, London, S.W.1 (February 10).

Geologist-Geophysicist, or a **Geologist** experienced in electrical methods of geophysical work, for the Uganda Geological Survey—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (February 12).

Lecturer in Psychology at the University of Tasmania—The Agent-General for Tasmania, Golden Cross House, Charing Cross, London, W.C.2 (February 15).

Lucas Chair in the Principles of Engineering Production—The Secretary, The University, Edmund Street, Birmingham 3 (February 15).

Senior Chemist to take charge of corrosion research on metal coatings with or without organic finishes, an **Electro-Chemist** for original research on the deposition of alloy coatings, an **Analytical Chemist** with experience in analysis of metals and alloys, and a **Librarian** (male or female) to take charge of scientific library and information service—The Director, Tin Research Institute, Fraser Road, Greenford, Middx. (February 28).

Assistant Directors in the Imperial Agricultural Bureaux of Soil Science, of Dairy Science, of Horticulture and Plantation Crops, and of Pastures and Forage Crops (including Field-Crops)—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (March 1).

University Librarian and Keeper of the Brotherton Collection—The Registrar, The University, Leeds (March 10).

Professor of Dairying—The Registrar, The University, Reading (March 17).

Topographical Engineer by the Government of Iraq for the Directorate General of Surveys—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17249.

Junior Technician in a physical research laboratory—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

Assistant Master to teach General Science and Mathematics up to Matriculation standard—The Principal, Dartford County Technical College, Essex Road, Dartford, Kent.

Head of the Physics Department—The Governing Body, Northern Polytechnic, Holloway, London, N.7.

Laboratory Assistant (man) at Coopers Hill Emergency Training College, Englefield Green, Surrey—The Education Officer (Estab./2), County Hall, Westminster Bridge, London, S.E.1.

Textile Technologist in India—The Secretary, Indian Jute Mills Association Research Institute, Imperial Institute, South Kensington, London, S.W.7.

Director of Research—The Secretary, British Leather Manufacturers' Research Association, 8 St. Thomas Street, London, S.E.1.

Research Assistant with experience of ultra-violet absorption spectroscopy—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3.

Deputy Head of the Library and Information Bureau, and a **Physicist** (young) for work on the application of physics and mathematics to problems of a mechanical nature—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Freshwater Biological Association of the British Empire. Fourteenth Annual Report for the Year ending 31st March 1946. Pp. 54. (Ambleside: Freshwater Biological Association of the British Empire, 1946.) 1*s.* 6*d.* [69

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UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANISATION

IN the debate in the House of Lords on December 3, in which the Government accepted Lord Vansittart's motion for the encouragement of the development of close political and economic relations between the countries of Western Europe, Lord Lindsay spoke eloquently of the importance of relaxing in every way possible the regulations which make travel and the intercourse of minds difficult. He rightly stressed the value of the contribution to the unification of Europe which could come from abundant intercourse between the young ; and on the cultural side, he also urged that energetic measures should be taken to deal with the scarcity of books, for books could be a real step towards establishing a common culture in Europe. Though the debate was pervaded with a sense of the ultimate necessity of such steps as Field-Marshal Smuts and Mr. Churchill have urged in recent speeches, no one suggested that a United States of Europe is as yet practical politics. Rather it was realized that there must be established once more that free intercourse of minds out of which creative ideas and action emerge in politics as well as in science and in art.

Something of the same impression came from the debate in the House of Commons on November 22 on the United Nations Educational, Scientific and Cultural Organisation. Quoting from the preamble to the constitution of the Organisation, "Since wars begin in the minds of men, it is in the minds of men that the defences of peace must be reconstructed", Mr. Eric Fletcher urged the importance of more public attention being given to the work of the Organisation which, if backed by an informed public opinion, could, he believed, make a vital contribution to international understanding. He suggested that attacks on illiteracy, on the revision of text-books, and on the general book shortage should be among the first tasks to which the new Organisation could set its hand. The scientific field offers many opportunities for co-operation, and Mr. Fletcher mentioned in particular a publication entitled "The Tasks and Functions of the Secretariat's Division of Natural Science". There is grave danger, he believes, that the United Nations Educational, Scientific and Cultural Organisation may attempt too much. In this he was vigorously supported by Mr. Kenneth Lindsay, who thinks that that has already occurred and that the Preparatory Commission ignored too much the growing points already in existence. Particularly in the scientific field, there are already many international bodies, some of which did not entirely cease to function even during the War. Dr. J. Needham, it is true, has pointed out the numerous gaps that persist, but it may well be that the Educational, Scientific and Cultural Organisation will serve the United Nations best if it is used here as a clearing house with a secretariat and a first-class personnel, and only establishes new bodies with great caution.

Mr. Lindsay pressed for more attention to the pioneer work of the Allied Ministers of Education, and pointed to the work of the Association of University Professors and Lecturers of Allied Countries in Great Britain as providing a nucleus on which an international body could be built up; such a body would certainly facilitate the fundamental educational work, from the university-level downwards. Other speakers in the debate urged that the Educational, Scientific and Cultural Organisation should keep to practical tasks really within its compass, and especially the restoration of educational systems, the exchange of students, the supply of adequate numbers of text-books and of other educational equipment; although it was also recognized that, if the Organisation is to succeed, there are other matters in which the active interest and support not merely of the Ministers of Education but also of other Government departments would be required.

Miss Ellen Wilkinson, Minister of Education, replying to the debate, promised that a summary or report of the first general conference of the United Nations Educational, Scientific and Cultural Organisation would be issued, either as a White Paper or a Ministry pamphlet. She accepted the principle of concentration on certain practical tasks, where it is a question of money and people and things to be done immediately, but she stoutly championed the idea of wide vision and unrestricted intercourse, rather than narrow conceptions of the ultimate functions of the Organisation. Speaking as chairman of the Preparatory Commission, Miss Wilkinson emphasized the importance of the delegations to the Conference being Government delegates with authority and also having wide influence and support in their own countries.

Miss Wilkinson then spoke specifically of the steps being taken to deal with the appalling destruction of all kinds of educational and scientific apparatus. In view of the world shortage of paper, the possibilities of microfilm in remedying the shortage of books are being explored. The needs of the Continent for scientific apparatus and laboratory equipment were surveyed by the Anglo-American Scientific Equipment Mission at the instance of the Educational, Scientific and Cultural Organisation early this year; it is estimated that material to the value of at least £9 million will be required, chiefly for the smaller and less expensive equipment, to restore the laboratories of the Continent to their pre-war level.

The way in which the Organisation could take over in the scientific and educational world, in the widest sense, the work being done by the United Nations Relief and Rehabilitation Administration has been discussed. Translations and a central pool of scientific information are other matters to which immediate attention is being given, but Miss Wilkinson urged that such immediate and practical tasks are not necessarily the most important. Much more important is that very difficult task of acting as a clearing house of minds; and in urging this, and showing that unless we can instil into the minds of youth standards of value, the sense of a difference between right and wrong, and the conviction that intellectual needs are not mere luxuries, the Minister of Education was in harmony with the whole trend of the debate in the House of Lords.

The Minister's speech is somewhat reassuring, for many have been not unreasonably disturbed at the mass of items with which the agenda for the recent conference of the Educational, Scientific and Cultural Organisation was packed. The value of many of the programmes suggested is undoubted; but their expediency at the present time can be seriously questioned. Not all of those specifically mentioned by the Minister can be regarded as so urgently important as measures to deal with the shortage of books, keenly felt even in British universities and even more on the Continent. Repair and replacement of the buildings, equipment, and libraries of great centres of learning destroyed during the War; the filling of the many gaps in sets of learned periodicals held by research and learned institutions of all kinds throughout the world, on which the research worker depends; and the freeing of scientific publications and of the exchange of students and research workers are the really urgent problems. On the speedy solution of them depends that cross-fertilization of mind, and that wider outlook and fuller understanding across frontiers, out of which must come slowly the thought and purpose which will shape the new political institutions and organs of co-operation needed by the world.

Miss Wilkinson recognized that such practical tasks cost money; it has been estimated that educational relief on the proper scale in Western Europe alone would cost £50,000,000. None the less, no wide discussion of general themes or ideas will avert a feeling of frustration and profound disappointment if the first conference of the Organisation does not result in a real attack, supplied liberally with funds, on educational relief in Europe. The Educational, Scientific and Cultural Organisation is primarily a piece of machinery, and it will best secure the support of public opinion and avoid the relative futility of the Committee on Intellectual Co-operation if it promotes such practical measures as have been mentioned. The whole trend of the House of Commons debate was behind such a view of the primary activities of the Organisation, and reflected the concern which the listing of seventy projects as of special urgency in the progress report of the Preparatory Commission, as well as the representation on a number of the committees, had engendered. The sense of the debate was quite opposed to the programme of philosophical collaboration outlined in the preparatory report, and on which Dr. Julian Huxley had spoken as a long-range aim. That can only be achieved after the barriers to the exchange of thought and knowledge are removed, and when the contact of mind with mind, and experience in working together in pursuit of common aims, lead to a fresh synthesis and formulation of the values of civilization.

No one could suggest that in the debate there was any desire to prolong or intensify ideological differences: in spite of the insistence on the values of Western civilization, there was just as evident a desire to see Soviet Russia fully associated with the Educational, Scientific and Cultural Organisation, as found expression at the conference last July on the

Organisation and the Universities arranged by the British Association, a report of which has now appeared in *The Advancement of Science* (4, No. 13; 1946). Sir Alfred Zimmern, in his opening address to the conference, rightly affirmed that the Organisation is bound to respect intellectual freedom and the unrestricted pursuit of truth, and that in its dealings with universities and other learned bodies it should avoid anything savouring of an attempt at control. The safeguarding of these values is indeed a major aim of the Organisation, and one in which it can count on the support of universities in every part of the world. But although Sir Alfred went on to discuss the form which co-operation between the universities and the Organisation would assume in practice, as well as that between the Organisation and other international associations such as the Council of Scientific Unions, few of the other speakers at the conference appear to have kept the discussion at a severely practical level.

The fact that the conference was also considering the report of the British Association's Committee on Post-War University Education may be partly responsible for this. Discussion was thereby drawn into a debate between two schools of thought: those who hold, like Mr. Bruce Truscot, that the purpose of universities is both the advancement and dissemination of knowledge, and those who, like Senor Ortega y Gasset, reject the research function and maintain that universities exist for the maintenance and propagation of broad cultural values and for the creation of an educated *élite*. We need, indeed, as Prof. Dobrée said, a far larger number of men and women, of university training, able to grasp ideas and aware of the conditions upon which our highly complex life is lived. Fuller and closer contacts between the universities in Great Britain and in other countries may well assist the development of new and more effective means of raising the general educational level and making international co-operation easier. But at the moment that task is surely second to that of getting the educational systems of Europe going again and repairing the havoc of war. Generous tribute was indeed paid by Prof. Jean Timmermans and others to the work of the Minister of Education and of the Association of University Professors and Lecturers of Allied Countries in Great Britain, the forerunner of the International Association; but little was said about the urgency of immediate educational reconstruction in Europe.

To compare the published report of the conference for the establishment of the United Nations Educational, Scientific and Cultural Organisation held in London in November 1945 with the programme which was presented to the Preparatory Commission in July (cf. *Nature*, August 31, p. 298) is to realize that there is some solid foundation for the belief that the priorities have been changed. It is true that there is no less emphasis laid on the importance of promoting increased co-operation and contact between philosophers, men of science, humanists, historians and others, and of the free and unrestricted exchange of ideas and knowledge, to the value of which both the Prime Minister and Miss Wilkinson testified at that conference, and which found expression in particular in the resolution concerning plans for a working arrangement between the Organisation and the International Council of Scientific Unions. The task of restoring and extending the means through which men of science of all lands may exchange information and work together for the advancement of knowledge and for its application to human needs is still recognized as urgent; but one misses in the later programme the sense of urgency, apparent, for example, in the instrument establishing the Preparatory Commission, which charged the Commission to appoint a special technical sub-committee to examine the problems relating to the educational, scientific and cultural needs of the countries devastated by the War, with a pointed reference to immediate action.

The original conference was fully aware of the urgency of such immediate practical problems, and was not anxious to establish fresh bodies. On the contrary, many speeches indicated the desire to build on, and to develop, existing institutions wherever possible. If, therefore, enthusiasm for the immense contribution which the United Nations Educational, Scientific and Cultural Organisation can make ultimately by promoting intelligent co-operation throughout the world, at all levels, seems to have led the Preparatory Commission rather astray from some of the more limited, immediately practicable objectives, there is reason for hope that the Paris Conference has redressed the balance. It may be found, when the promised report appears, that ideals and long-term policy have been harmonized with an immediate practical programme directed to assist the reconstruction of European educational systems. Outside the Organisation itself, indeed, support is already forthcoming for practical measures—the recent appropriation to the Organisation from the American Chemical Society for promoting the exchange of chemists and chemical engineers between different countries is one example—and it will be noted that the reconstruction of education in Europe was indeed placed first by the Preparatory Commission on its list of programmes. It is from the demonstration of its ability to minister to these imperative practical needs that the Organisation will draw the public support and understanding necessary for the formulation and/execution of wider and more far-reaching plans for bringing the nations together in cultural and intellectual co-operation, and focusing the full force of human intelligence on the task of forging a peaceful co-operative community.

These immediate tasks are in fact but the stepping-stones from which the Organisation should move forward to develop and increase the means of communication between its members, to foster the unrestricted pursuit of truth and the free exchange of thought out of which may ultimately develop something of a world community, and the creative thought which will shape the appropriate instruments of world order to serve the needs of modern society. Neither education nor research can, however, be unifying forces in the world, until these first steps have been taken, and on them our attention should for the moment be focused.

BACTERIOLOGY AND IMMUNITY

Topley and Wilson's Principles of Bacteriology and Immunity

Third edition, revised by Prof. G. S. Wilson and Prof. A. A. Miles. Vol. 1. Pp. xi + 970 + xliv. Vol. 2. Pp. viii + 971–2,054 + xliv. (London: Edward Arnold and Co., 1946.) 2 vols., 60*s*. net.

THIS edition, the third in seventeen years, following four printings of the first and seven of the second edition, indicates a large and steady demand for the work. The late Prof. Topley had withdrawn from authorship, and the latest revision has been undertaken by Profs. Wilson and Miles. The plan of the work, which is divided into four parts in two volumes of about a thousand pages each, has remained as before.

Part 1, by way of introduction, treats of "General Bacteriology", including the history of the science, bacterial morphology and metabolism in their broad aspects, with subsequent chapters on matters of practical interest to the hygienist and physician concerning disinfection and what may be summed up as chemotherapy. Then the phenomena of antigens and antibodies are considered, and this part closes with sections on bacterial variation, classification and the bacteriophage. Part 2, headed "Systematic Bacteriology", commences with a short description of methods of obtaining pure cultures of bacteria and identifying them. Following this, a series of chapters deal with the various groups of bacteria in a sequence which would probably not be used in teaching the subject, since it begins with Actinomyces, then goes on to *Erysipelothrix* and *Listerella*, next to the tubercle bacillus group, diphtheroids, anaerobic or micro-aerophilic Gram-negative bacilli of the Fusiformis group, etc., while *Streptococcus* and *Staphylococcus* come later. This part, which finishes with the general properties of the animal viruses, comprises a most extensive collection of the characters of a very large series of bacteria and will prove of much use to workers in the fields of veterinary and economic bacteriology as well as to medical bacteriologists. Part 3, which occupies three hundred pages, is concerned with "Infection and Resistance". These important subjects are considered very fully and with a wealth of detail. Part 4, the final division of the work, is entitled "The Application of Bacteriology to Medicine and Hygiene". Here the chapter headings correspond to a considerable extent with those in Part 2, and much information is given for clinicians and administrators about the diseases caused by the pathogenic members of the groups discussed earlier. But, of course, complete correspondence is impossible, since, for example, suppuration is due to a wide variety of organisms. Toward one third of the way through the list one finds in sequence chapters on "Cholera", "Meningitis", "Gonorrhœa", "Scarlet Fever and other Diseases due to Hæmolytic Streptococci", "Pyogenic and Wound Infections", "The Bacteriology of Rheumatic Infections and of Endocarditis". This indicates that meanwhile only piecemeal treatment of bacteriology is possible. Such is likely to remain the case until 'general' bacteriology is studied for its own sake and the chief interest ceases to be the production by a given organism of a specific disease or some particular chemical reaction. However, it may be argued whether the most suitable arrangement is secured by separating by more than eight hundred pages consideration of the microscopic and cultural characters of the tubercle bacillus and the diphtheria bacillus from the sections on tuberculosis and diphtheria; after all, the production of these diseases is the most noteworthy characteristic of the two organisms. Accordingly, it will be clear that the work is essentially one for reference. To the practising bacteriologist the book is invaluable; it gives very full lists of publications, and the attention paid to recent literature effects a great saving in the reader's time by indicating what he ought to consult in the original. It may, of course, be considered captious to criticize the book for what it does not contain, but, like a number of other text-books on bacteriology in English, it omits very largely details of procedures. While it is self-evident that skill in bacteriological methods cannot be acquired except by practical work in the laboratory, nevertheless a considerable amount of description and specification in print is required for reference. Also, advances in knowledge can come only through the channel of experimental methods. Therefore, it is to be regretted that no companion volume is available dealing more extensively with the authors' laboratory practice. A further loss of another kind is entailed by limiting consideration to the ordinary bacteria, spirochætes, rickettsiæ and viruses, while omitting pathogenic Protozoa and Fungi. The pathogenic Protozoa, which are so like many of these other organisms in their effects on the living body of the host, and which are studied by essentially similar techniques, could with great advantage have been included. Discussion on the causes of bacillary dysentery and exclusion of amœbic dysentery is a case in point. Also, any exposition of chemotherapy must suffer from a presentation which, with the limitations imposed, cannot help devoting chief attention to the sulphonamides and penicillin. In connexion with chemotherapy one wonders what is the authority for the statement (p. 155) that Ehrlich's great pioneer work "started in 1905 with a systematic search for a cure for syphilis". The reviewer remembers well remarks made by Ehrlich (about 1906) emphasizing how the experimental pharmacologists up to that time had chiefly concentrated on toxicology, while his own aim was "kranke Tiere heilen".

The book as a whole is emphatically not for the use of the higher forms in schools. So far as undergraduate and postgraduate students preparing for examinations are concerned, one feels that a few selected chapters should be prescribed as a training on how to assess the literature critically. However, we owe a debt equally to the authors and the publishers of "Topley and Wilson's Principles" for making this mass of up-to-date information available at a very modest price. The authors must also be congratulated on the organisation which has enabled them to marshall the almost overwhelming mass of printed matter which has had to be dealt with in its preparation. A conservative estimate places the contents at about 1,200,000 words, while the Medical Research Council's "System of Bacteriology" in nine volumes contains about two million words. It is unfortunate that exigencies imposed on the production of a book such as the "Principles" make it necessary to deal with an actively growing subject like bacteriology in this way. A series of monographs would, we think, serve much better the interests of users. These separate volumes could then be brought up to date independently as advances required.

C. H. BROWNING

THE AIRY INTEGRAL

British Association for the Advancement of Science Mathematical Tables. Part-Volume B: The Airy Integral, giving Tables of Solutions of the Differential Equation $y'' = xy$. Prepared by J. C. P. Miller. Pp. B.56. (Cambridge: At the University Press, 1946.) 10*s*. net.

THE tabulation in this volume is mainly concerned with the function $Ai(x)$ and its derivative, and before discussing the actual details of the tables, it is instructive to recall the history of the function.

A little over one hundred years ago, in calculations relating to the light-intensity in the neighbourhood of a caustic, Airy was confronted with the integral

$$W = \int_0^\infty \cos \tfrac{1}{2}\pi\,(w^3 - mw)\,dw,$$

and succeeded in producing a 5-decimal table for values of m ranging between ± 4, later extended to ± 5·6.

It can be deduced that W satisfies the differential equation

$$\frac{d^2W}{dm^2} = -\frac{1}{12}\pi^2 m\,W,$$

and hence that the problem of computing it is effectively that of computing the solutions of the second order differential equation

$$\frac{d^2y}{dx^2} = xy.$$

The form of this last equation suggests that its solutions are closely allied to Bessel functions of a certain order, and denoting them by $Ai(x)$ and $Bi(x)$, it may be shown, for example, that when x is real and positive,

$$Ai\,(-x) = \tfrac{1}{3}\,x^{\frac{1}{2}}\,\{J_{-\frac{1}{3}}\,(\xi) + J_{\frac{1}{3}}\,(\xi)\}$$
$$Bi\,(-x) = (\tfrac{1}{3}\,x)^{\frac{1}{2}}\,\{J_{-\frac{1}{3}}\,(\xi) - J_{\frac{1}{3}}\,(\xi)\}$$

where $\xi = \frac{2}{3}x^{3/2}$, with similar results for positive arguments in terms of modified functions.

Recently the demand for tables of the Airy integral has revived; a revival closely connected with the simplicity of the differential equation above, and in virtue of which the British Association, through its tables committee, has prepared this volume (issued as Part-Volume *B*, in conjunction with a volume dealing with the tabulation of Legendre polynomials).

It is provided with a substantial introduction discussing the history of the function, the formulæ and equations involved, and the methods of computing and checking. This occupies some fifteen pages and is followed by tables of $Ai(x)$ and $Ai'(x)$, for the range $x = -20$ to $x = 2$, at intervals of 0·01, the entries being to eight decimal places, with second differences.

Subsidiary tables of the logarithms, zeros and turning values of the functions are also included, and similar results for the *Bi* functions for the range − 10·0 (0·1) + 2·5 are provided. Finally there are eight pages of tables of auxiliary functions, with definitions and formulæ.

The whole book is beautifully produced and does its authors great credit. It is interesting, in conclusion, to note that Airy's original computations, in spite of the exceedingly laborious work which they involved, were almost entirely devoid of error.

J. H. PEARCE

MAP PROJECTIONS

Map Projections

By George P. Kellaway. Pp. viii + 128. (London: Methuen and Co., Ltd., 1946.) 10*s*. 6*d*. net.

WE welcome a book whose "aim is to provide students of geography with a logical treatment of the commoner map projections". A careful study leaves no doubt of its value as a contribution to the teaching of the subject: the plan is well conceived and skilfully executed.

The earth sphere, latitude and longitude are compressed into four pages, which lead to discussion of the fundamental problem of representation of the earth on flat maps. There is a double classification based on: (1) nature—perspective, geometrical and conventional; (2) construction—on plane, cylinder or cone.

Part 1 begins with polar maps: the order gnomonic, stereographic, orthographic is surprising; there is something to be said for beginning with the sphere as ordinarily seen. Cylindricals follow, and here the discussion of Cassini's is particularly welcome though the construction is not detailed, probably because it is too difficult for those for whom the book is intended. Conicals, ending with Bonne's, complete the geometrical types. Conventionals open with Sanson-Flamsteed. Aitoff receives due notice as an improvement on Mollweide.

The plan of treatment in each case is: (1) mathematical basis; (2) statistical examination of properties at regular latitude intervals; (3) summary of general properties; (4) limitations; (5) construction. The statistical treatment leads to the study of limitations. This is very thoroughly done. Perhaps, after full treatment in one case and a beginning in others, something might, with advantage, have been left for the student to do; on the other hand, much labour has provided some very acceptable reference material.

Part 2 deals with equatorial zenithals and obliques. The outstanding impression is that the author is deeply concerned, and quite rightly, that the student should realize the importance, in dealing with approximations, of considering the degree of accuracy attained. One would like to think of non-mathematical geographers at school or university being at home with the mathematical work, in these days of numerical trigonometry to School Certificate. To follow the manipulative work would be a severe tax; at worst, the student can take it as read, pay due attention to the statistical data and construct according to instructions. No student can really be said to have studied map projections without constructive work.

The book ends with an admirable discussion of the use of various projections and a collection of representative questions set by university examining boards. Could we not give them a lead in setting questions concerned with travel, and would it not be worth while for examiners to ask a candidate to construct rather than write about projections, at least sometimes?

In conclusion, the reviewer has read the book with real pleasure: he feels no hesitation in recommending its careful study by those seeking a stimulating textbook on the subject or a worthy addition to the geographical library. He congratulates author, publisher and printers on an excellent production.

A. HINCKLEY

The United Nations

A Handbook on the New World Organisation. By Louis Dolivet. Pp. 144. (London : Phœnix House, Ltd., 1946.) 6*s*. net.

IT is probably true to say that the prestige of the United Nations Organisation has fallen as much in twelve months as that of the League of Nations fell in as many years. Disillusionment and bewilderment are as widespread as the realization that, for all such disappointment, the diagnosis of the founders of the Organisation remains correct. It is still true that Western civilization cannot indefinitely sustain the strain imposed upon it by the conflicting interests of the Great Powers.

If, however, this situation is to be retrieved and the United Nations Organisation is to succeed in its objectives, it must have the firm support of individual men and women throughout the world. That support must be based on clear understanding of the ramifications of the Organisation, the diversity of its problems and the mechanics of its operations. Mr. Dolivet's handbook is an objective contribution to that end. It is not a commentary; but a conscientious and workman-like attempt to give a factual picture of the actual structure and purposes of the Organisation. The book is readable, and although in some respects incomplete, being free from any attempt to record achievements or current controversies, it should assist the ordinary citizen to arrive at some independent judgment for himself. The appendixes include the Charter of the United Nations, the Statute of the International Court of Justice, and the names of representatives on the Security Council, the Military Staff Committee, the Atomic Energy Commission, and the delegates to the Economic and Social Council and to the First Assembly. If to future editions there could be added similar factual presentations of the relations with, and functions of, the Educational, Scientific and Cultural Organisation, the Food and Agricultural Organisation, and the like, which are in this edition rather summarily discussed, and of the trusteeship developments, it could well become a reference book that the ordinary citizen would be glad to have at hand.

R. B.

Les Liquides Dispersifs et leurs Applications

Par Dr. G. Ahier. Pp. 88. (Paris : Jouve et Cie., 1940.)

OWING to war conditions, this interesting monograph has only recently become available in Great Britain. It forms a useful summary of a great deal of work on the applications of liquids of high dispersivity, especially to the construction of Christiansen filters (*C.R. Acad. Sci., Paris*, 202, 1775 (1936) ; 205, 37 (1937) ; 206, 203 (1938)).

Christiansen filters consist essentially of a powdered solid immersed in a liquid of similar refractive index but different dispersivity. For one wave-length, the refractive indices are equal ; the mixture is then homogeneous and transparent to this wave-length, while all other wave-lengths are scattered. The literature records the use of a number of such filters. Dr. Ahier's book discusses the theory of these filters, and derives formulæ which may assist in their construction. He also describes fully a series of liquids and solids with which he assembled filters which selected narrow bands of wave-lengths, from the visible region down to 1850 A. Careful manipulation renders it possible to isolate bands, which, in some cases, were only 3 A. wide. The merits and defects of Christiansen filters are compared with those coloured filters and monochromators. In genera Christiansen filters are cheaper, more easily mad and more satisfactory from the point of view of bot selectivity and optical density.

Dr. Ahier's book should be useful to workers r quiring light filters, partly as a practical handboo and partly as a review of the subject, including t infra-red region.

G. J. MINKOFF

Chemical Thermodynamics

By Dr. J. A. V. Butler. Fourth edition. Pp. xvi+57 (London : Macmillan and Co., Ltd., 1946.) 12*s*. 6

IN this book, the author has brought together one volume the two parts of his introduction thermodynamics, which were formerly publish separately. The first part gives a straightforward a elementary account of the first and second laws, a their application, with the emphasis towards electr chemistry. The second part, which is considerab more advanced, deals with the more importa thermodynamic functions and the third law, a their applications. This part has been revis and brought up to date, and a good deal of ne material added. The revision could, with advantag have been extended to Part 1 ; even the younge student may, in this atomic age, raise his eyebro at the statement on p. 4 that "According to som modern physical theories, matter and energy a interconvertible. If this were substantiated, th Conservation of Energy would be replaced by wider principle of the Conservation of Mass-Energy." There might also, with advantage, hav been a closer synthesis of the text of the two parts.

The book contains a good deal more than its tit implies, and discussions of detailed mechanisms a frequently included. This adds considerably to th value of the book, since it gets down to fundamental In particular, the author writes interestingly and we on the subjects in which he has made original co tributions, such as the kinetic theory of the electro processes, or the mechanism of over-potential. The is a large number of well-selected examples, many which are worked out ; and a short but very cle account of the application of statistical methods the determination of thermodynamic functions, the late Dr. W. J. C. Orr, has been added as a appendix. The book should continue to prove useful and stimulating introduction to the subject.

F. P. BOWDEN

General Mathematics

By Clement V. Durell. Vol. 1. Pp. xv+312+xlv Vol. 2. Pp. xxxi+324+xl. (London : G. Bell an Sons, Ltd., 1946.) 5*s*. without Answers ; 5*s*. 6*d*. wit Answers, each Vol.

AS Mr. Durell rightly says in his preface, "el mentary mathematics should be treated as single subject". The course embodies many mode ideas of teaching designed to meet the expanding an changing needs of post-war secondary schools. deals with arithmetic, algebra, geometry and tri onometry, and covers all the requirements laid dow in the current syllabuses of the various Scho Certificate examining authorities.

Each book contains many exercises which a classified into two main groups : a first course, an a parallel course. The first is intended for all pupil while the second provides extra practice. Usef test papers and revision exercises are supplie together with answers to all exercises.

THE 'CYTOGENETICS' OF BLACK AND WHITE GUINEA PIG SKIN

By R. E. BILLINGHAM and P. B. MEDAWAR
Department of Zoology and Comparative Anatomy, University of Oxford

IT is an obvious empirical fact that the differentiated cells of the adult organism, if they are capable of dividing at all, 'breed true' and preserve for ever in cellular inheritance their specificity of histological type. Even under the regime of tissue culture, in which a cell lineage may well comprise a hundred generations, there is no reduction of embryological rank, and no degradation of histological specificity that is not a mere matter of 'nurture' and reversible at will. What is the mechanism of conservative inheritance in the cell lineages generated by mere asexual fission ? An attempt will be made to answer this question by special reference to two cytogenetically distinct but closely related types of cell: those of the 'white' and 'black' epidermal epithelia of guinea pigs' skin. It will be suggested that the inherited difference between them is due to the possession by the black epidermis of a cytoplasmic self-reproducing system concerned with melanogenesis that has some of the properties of what are usually called 'viruses'. Analysis of the type we have undertaken is, indeed, only made possible by the circumstance that black skin is capable of 'infecting' white, and endowing it with its own cellular phenotype ; a process which is in some respects analogous to a cross between sexual organisms, and which has the same methodological significance for the study of cellular heredity as the phenomenon of segregation has for Mendelian genetics.

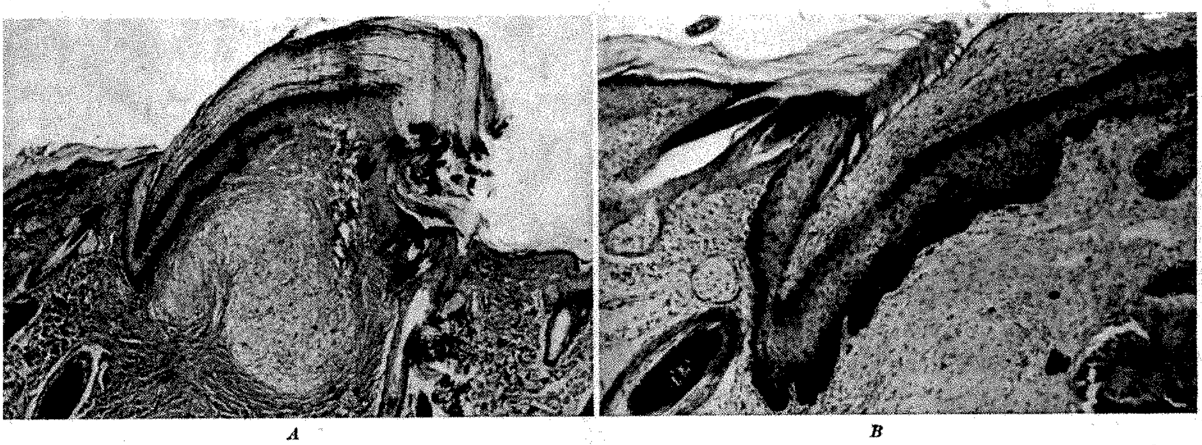
The skin that bears black hairs in a spotted black-and-white guinea pig is itself black in colour. This is because the basal layer cells of its epidermis contain melanin granules. (In rabbits and mice, by contrast, any apparent pigmentation of the skin itself is due to melanin granules housed in the hair follicles alone.) It has been known for fifty years[1,2] that if black guinea pig skin is grafted to a white area on the same animal, a process that may non-committally be called 'infection' takes place: the white skin that surrounds the black graft blackens centrifugally, though the hairs that grow on infected white skin almost invariably stay white. Conversely, white skin grafted to a black area in due course blackens.

Loeb's explanation[3] of the phenomenon is as follows. "The pigmented epidermis is the stronger one" ; and because of the physiological disturbance entailed by grafting, it "asserts its authority over the white epithelium", and in the "struggle" that ensues, it wins. Bleached of its metaphorical colourings, the theory amounts to this : for reasons not yet clear, black skin grows into and displaces white[4].

There is no convincing histological evidence that any such process of invasive replacement takes place, save perhaps in the irrelevant special case in which a white graft from one guinea pig (a homograft) is transplanted to a black area on another. We have now conclusive evidence that no replacement occurs. For if the white epithelium of the lunula of a white claw[5] is transplanted to a black area on the skin of the chest, it promptly blackens and produces a jet black claw in the normal skin area (Figs. *A*, *B*). White sole-of-foot or vaginal epithelium transplanted to black areas of dorsal skin likewise promptly blacken, while retaining all their other easily recognizable graft-specific characters, such as the high growth-rate and dense stratum corneum of the sole-of-foot graft, from which a thick pad of compact cuticle may be removed weekly. Moreover, if a white sole-of-foot graft is caused to blacken by grafting to a black area of dorsal skin, it may then be removed and returned to its original surroundings ; whereupon the white sole is blackened at second hand by something evidently derived in the first instance from dorsal skin. Results such as these must be held to refute the hypothesis of cellular replacement. If, for example, black dorsal skin epithelium had in fact replaced white claw-forming epithelium, it could scarcely be expected to form a black claw. *Mutatis mutandis*, the same applies to sole-of-foot and vaginal grafts.

Other hypotheses may now be considered.

(1) The blackening of white skin around a black graft is due to the simple diffusion from cell to cell of enzymes or co-enzymes concerned with melanogenesis. In principle, this does not differ from the outward diffusion of a black dye from the graft, supposing that its epithelium were black merely because it had been stained by a black vital dye.



(*A*) VERTICAL SECTION THROUGH A BLACKENED CLAW THAT HAS DEVELOPED FROM A SMALL GRAFT OF WHITE LUNULAR EPITHELIUM 33 DAYS AFTER TRANSPLANTATION TO THE BLACK SKIN OF THE CHEST. THE BASAL LAYERS OF THE CLAW EPITHELIUM AND THE CLAW SUBSTANCE ITSELF ARE LOADED WITH MELANIN GRANULES. HÆMATOXYLIN AND VAN GIESON. (*B*) A VIEW IN HIGHER POWER OF THE CLAW-SKIN JUNCTION : FROM A NEIGHBOURING SECTION STAINED WITH EHRLICH'S HÆMATOXYLIN AND ORANGE-G. THE UNIFORM INFECTIVE PIGMENTATION OF THE CLAW EPITHELIUM IS OBVIOUS. NOTE THE ABRUPT TRANSITION BETWEEN SKIN AND CLAW EPITHELIUM, AS INDICATED BY THE CHANGE IN THE STRUCTURE OF THE STRATUM CORNEUM

This hypothesis is untenable because the 'blackness' of artificially blackened white skin becomes a heritable characteristic of its cells. The induced blackness of even so mitotically active an epithelium as that of the sole does not diminish during the dozens of cellular generations through which it must pass in a period of three or four months. In certain circumstances, indeed, it may increase. Moreover, as Fessler first showed[6], if part of the blackened annulus surrounding a black-in-white graft is removed and transferred to a white area, it duly infects the surrounding white skin; and part of this newly formed blackened annulus may in turn blacken its surroundings if grafted to a white area elsewhere. In short: whatever maintains the formation of melanin granules in artificially blackened white skin multiplies with the cells that house it.

(2) A second explanation, therefore, is that the process of contagious infective blackening is produced by the diffusion from black cells into white of a self-reproducing entity that is part of the normal equipment of cytogenetically black cells. This entity spreads like a virus from cell to cell, possibly across the cytoplasmic bridges that are said to unite epidermal cells of the prickle layer; and, being self-reproducing, brings about a change in the white epidermal cells that is thereafter permanently conserved in cellular heredity. It is irrelevant to this interpretation whether the postulated entity is an enzyme, co-enzyme, enzyme vehicle, or colloidal micelle of the 'microsome' type[7]. The point is that it must be supposed to reproduce itself. There are two reasons for supposing that any such entity must be housed in the cytoplasm: (*a*) it must evidently come out of the nucleus, if stationed there, to infect a neighbouring cell; and (*b*) one is not yet entitled to suppose that black and white epidermal cells of the same individual have different complements of nuclear genes. Yet there is no doubt that nuclear genes *do* initiate pigmentation and govern the pattern of its distribution; and we are led to suggest, by analogy with the known behaviour of the 'cytogenes' of yeasts[8,9], that the cytoplasmic factor is gene-initiated but not gene-maintained. Indeed, it is difficult to conceive how the different cell-races of the individual body come to acquire their specificity of histological type, and to maintain it indefinitely in cellular heredity, without postulating the existence of such self-reproducing bodies in the cytoplasm. They may initially have been called into being by some specific act of co-operation between nuclear genes and an external 'morphogenetic' stimulus; but thereafter they maintain themselves autonomously in the cytoplasm. It was to examine a hypothesis of this type that the experiments described here were done; and it was the speculations of Darlington[10] and Haddow[11] that set us thinking on these lines.

There are already several candidates for admission to the status of self-reproducing cytoplasmic 'genes' or proprietary viruses, namely, 'cytogenes', 'plasmagenes'[10], and factors of the type described by Sonneborn[12]; and the idea that such factors play a determinative part in somatic cellular differentiation and heredity is far from new[7,9,11,13]. The inherited difference between black and white epidermal cells is a test case for the following reasons: (i) the two cell types are cytogenetically very similar; (ii) they are nevertheless cytogenetically distinct, and in a superficially obvious way; (iii) black and white epidermal cells can establish just that intimate cytoplasmic contact that may in most cases be necessary for infection to take place. It may prove possible to strengthen our hypothesis by showing that the infective agent that turns white cells black can be introduced into white cells in cell-free extract. Tests of this type are in their early stages, and they have not yet been successful. It seems unlikely that cells of other types should lend themselves so easily to experiments on infective transformation. One could scarcely hope to turn a liver cell, say, into a cell of thyroid epithelium; but it might not prove impossible to endow an undifferentiated fibroblast with osteogenic power.

(3) It is only by analogy with the behaviour of 'viruses'[10] and the cytoplasmic factors of yeasts[8,9] that we have been led to suggest that the infective agent we are dealing with is *itself* self-reproducing. By analogy with what the embryologist has called 'homoiogenetic induction'[14] we might equally well liken it to an 'evocator', that is, to a substance that merely *initiates* the formation of such self-reproducing bodies in the cytoplasm and, consequently, a change of cellular phenotype that is thereafter self-sustained. Now viruses multiply only in association with living cells; and some viruses, like our own candidate, can only multiply in cells of a very restricted type. (As will be shown later, the epidermal epithelium of the tongue is not overtly infectable.) To show that the infective agent we are dealing with is 'really' self-reproducing, we cannot but introduce it into cells of the type that it is known to infect, and show that it multiplies there; in other words, perform the very test that fails to disqualify the alternative view that it is 'really' a morphogenetic hormone. We could, of course, distinguish between virus and evocator by an arbitrary act of definition—as by saying that viruses are always associated with nucleo-proteins and evocators with sterolic compounds; but to attempt to do so before we are much clearer about the form which such a definition had best be made to take might be a real misfortune, born of a deep-seated but perhaps mistaken belief in the propriety of 'always defining one's terms'. All we can say is that the properties of our infective agent relate it more closely to the things which people who study 'viruses' call by that name. For example, black skin *homo*grafts (see above) do not elicit a blackening reaction when grafted to white skin[15]; even, we find, when grafted in such low dosage[16] that they should have time, before their eventual destruction, to infect the neighbouring epidermal cells of the host. The infective agent is therefore iso-antigenic, or is closely associated with something that is. This is perfectly consistent with a virus-type theory of infection, for reasons that involve too many details of the theory of transplantation immunity to be discussed here; but less obviously consistent with a simple 'evocator' theory, since most evocators are not even species-specific in their action.

Pending the publication of a full report, we may take this opportunity of mentioning some of our other experimental findings. (*a*) White tongue epithelium does not blacken in a black skin environment. Even months after grafting, the margin of contact between black skin epithelium and white tongue epithelium (with its characteristic cuticle, and without granular layer) may be distinguished to a cellular boundary. Tongue epithelium may be cytogenetically too far removed from that of skin for such a process of infection to take place; and it may be relevant that we have not so far seen a naturally occurring pigmentation in the tongue of the guinea pig, although feet, claws, and vagina are pigmented in some individuals. (*b*) The process of infection occurs mainly in the basal layers of the superficial (as opposed to follicular) epidermis, so that the hairs borne by artificially blackened white skin tend to remain white, even after manipulative treatment (such as grafting itself) which causes the hairs to be thrown off and replaced by new. We believe that this is because the primordia of new hairs are usually formed from the bases or shafts of the old follicles, to which the infective agent does not gain access (possibly because the rate of upward flow or migration of follicle epithelium is greater than the rate of spread of infection downwards). But black hairs *do* sometimes form in artificially blackened white epithelium; as often, it may be, as the primordia of new hairs are budded off from the blackened superficial epithelium rather than from the epithelium of effete follicles. (*c*) Contrary to the belief of Fessler[6], skin grafts, competently transplanted, invariably grow hairs. (*d*) The rate of blackening of a white-in-black graft seems to vary directly with the intrinsic (that is, 'graft-specific') rate of cell division in the epidermal graft. It is particularly high in sole-of-foot and claw-forming epithelia, and white grafts of such epithelia blacken in a matter of weeks. The rate of centripetal blackening of a white dorsal skin graft in a black skin area is, however, anomalously slow: we do not yet know why. (*e*) The pigmented character of artificially blackened epithelia of all types is a property of *all* the cells of their basal layers (cf. Fig. *B*). Whatever may be the role of melanophores in amphibian skin grafts, we have no evidence that they play any primary part in the phenomena we have described.

Summary. Black guinea pig epidermis has the power to 'infect' neighbouring white epidermis, and so to blacken it. This is shown not to be due to a cellular invasion and a replacement of white cells by black. It is due to an agent which, having entered white cells, brings about a permanent heritable change that causes them and their descendants to remain thereafter black. The infective agent may be a self-reproducing body housed normally in the cytoplasm; or, less probably, it may be a morphogenetic hormone that merely initiates the formation of such self-reproducing bodies in the white cells which it infects. The experiments described have a direct bearing on the problems of somatic cellular differentiation and heredity.

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FUNDAMENTAL PROBLEMS IN MODERN PHYSICS

THE Physical Society intends to hold a series of ordinary meetings at places outside London, and the first of these took place in the Physics Department of the University of Birmingham on December 20. This meeting, which took the form of a one-day conference under the general title "Fundamental Problems in Modern Physics", was attended by about two hundred fellows of the Society and visitors from universities, government establishments and industrial firms. The morning session was devoted to three papers; in the first, Prof. R. E. Peierls, of the University of Birmingham, discussed some of the outstanding difficulties of fundamental theoretical physics, and indicated the type of experimental evidence which would be most valuable in resolving them. He was followed by Mr. J. S. Gooden, also of the University of Birmingham, who read a paper on the design of a proton synchrotron, with special reference to the factors influencing the amplitude of phase oscillations of the particles and consequently affecting the intensity of the emergent beam. The third paper, by Mr. D. W. Fry, of the Telecommunications Research Establishment, dealt with some practical aspects of synchrotron design, in the light of experience gained with the three electron synchrotrons already under construction in Great Britain. A paper by Prof. J. Sayers, of the University of Birmingham, on recombination phenomena in highly ionized gases, opened the afternoon session; Prof. Sayers was unfortunately not able to be present at the meeting, but his paper was read by Prof. P. B. Moon. The conference closed with a paper by Dr. F. Hoyle, of Cambridge, on the synthesis of heavy elements from hydrogen in stars, and their distribution throughout space.

Prof. Peierls suggested three main lines of experimental investigation from which information useful to the theoretical physicist may be forthcoming. In the first of these, the energies of the nuclear particles involved are not excessive, and the greatest need is for improvement of measuring apparatus and for a systematic collection of results. In the case of β-disintegration, for example, it is now known that some of the apparent discrepancies between experiment and the original Fermi theory were due to experimental difficulties which have since been overcome; but there still remains some freedom of choice in formulating the theory, which can be narrowed down only by detailed knowledge of quantities such as the spin and symmetry of the initial and final nucleus and the distribution in energy of the emitted particles.

With regard to the short-range forces between particles in complex nuclei, Prof. Peierls pointed out that although Bohr's 'liquid drop' model represents the qualitative properties of such nuclei reasonably well, the assumptions made are independent of the nature of the forces involved, and hence the deductions drawn from them can give no information on this point.

Even if the laws of force were known, it would be impossible to calculate exactly the values of the energy-levels of complex nuclei, on account of the large number of particles involved. We must therefore discuss these nuclei in a statistical way, and so it becomes important to have a large amount of experimental data systematically collected. The importance of each individual item might seem small, but that of the whole would be considerable if an effort were made to obtain as much information as possible about each energy-level, and great care were taken to proceed systematically in those cases where it is necessary to obtain information from transitions between two levels.

The difficulties with which the theoretical physicist has to contend in describing nuclear processes while still ignorant of the law of force between the particles are augmented by doubts as to the limits of applicability of the fundamental mechanical laws. For example, an unstable condition is predicted on extrapolating to short distances the law expressing the non-central force between the components of the deuteron. Experimental data on neutron–proton collisions, when the bombarding particle has a de Broglie wave-length of the same order of magnitude as the distance at which the simple law breaks down, would therefore be of value in suggesting suitable modifications for use at these distances. Particles with kinetic energy in the region of 12 MeV., or greater if possible, would be required, and accurate data from the scattering experiments are essential. Turning to experiments in which very high energies are required, Prof. Peierls pointed out that existing theory breaks down completely when applied to particles the distances of approach of which are of the order of 10^{-13} cm., and to states existing for the order of 10^{-23} sec. To provide a signpost for theory in this region, the study of collisions between elementary particles at energies of the order of 100 MeV. is necessary. Another possible outcome of experiments on particles with energies in the 100 MeV. region is the production of mesons in controllable experimental conditions, whereupon it might be possible to investigate their electric charge, to ascertain whether they have a range of masses, and to obtain further data on their spin, in circumstances more amenable to interpretation than those existing at present, when the only source of mesons is cosmic radiation.

In the two papers which followed, Mr. Gooden and Mr. Fry took up Prof. Peierls' challenge to practical physics by showing how high-energy particles might be obtained. Referring to the proton synchrotron under construction at the University of Birmingham, Mr. Gooden showed that in the case where the particle velocity, and consequently the frequency of the accelerating radio-frequency field, increases with increasing particle energy, some particles will possess a phase oscillation the amplitude of which is to a first approximation constant, and might, under certain conditions, steadily increase. If the amplitude is allowed to increase, these particles enter the region of unstable phase, and are lost from the circulating beam. Particles can, however, be accelerated provided that a careful control is exercised in the choice of those physical variables which affect the amplitude of the oscillation. Mr. Gooden showed that there are no less than eight significant forces affecting this oscillation, four of which cannot be varied. Three of these are associated with the radial displacement of a particle from the central, or stable, orbit, since such displacements determine the energy gain per revolution required to maintain the particle in its instantaneous orbit, the amount of magnetic flux enclosed by the orbit, and the response of the particle to changes in the frequency of the accelerating electric field. The fourth invariable force arises from the fact that, as the total kinetic energy of the particle increases, the radial displacement resulting from the given change in the energy-gain per revolution becomes smaller. The combined effect of these four forces is to produce a very small damping of the phase oscillation in the case of acceleration of protons to energies of about 1,000 MeV. The four variable forces were then discussed; these were shown to depend on the rate of change of the frequency and amplitude of the accelerating field, the form of time variation adopted for the magnetic field, and the shape of the faces of the accelerating chamber. Finally, Mr. Gooden considered the factors affecting the number of radio-frequency cycles, and the time interval per cycle, during which particles could be accepted for acceleration.

Mr. Fry restricted his attention to electron synchrotrons, and therefore discussed only those types of machine in which the initial acceleration (to velocities of about 0·98c) is obtained by betatron action, the radio-frequency accelerating pulse being phased to start just as the betatron core begins to become saturated. When the particle velocity is nearly equal to that of light, the orbital frequency will remain constant if the radius of the orbit is kept constant by suitable increase of the magnetic field with time; the frequency of the alternating voltage between the accelerating electrodes can then be constant during each pulse. After mentioning the essential components of a synchrotron system and the relative times at which the voltages must be applied to the injection gun, accelerating electrodes and ejection coils, Mr. Fry went on to describe the magnet systems used in the 30 MeV. machine designed by the Telecommunication Research Establishment and the 300 MeV. synchrotron which is being made by Metropolitan-Vickers with help from the Establishment for the University of Glasgow. To reduce the magnet weight, it is convenient to use a symmetrical iron circuit of high-quality laminations in which a high flux density can be achieved. Considerations of the maximum energy which has to be stored in the field show that it is desirable to keep the volume of the annulus in which the particles circulate as small as possible; this, in turn, necessitates very careful design and construction to prevent particles from being lost on account of irregularities or out-of-phase fields produced in air gaps by leakage from the magnet stampings. In the case of the 300 MeV. machine, the stored energy is supplied by a condenser bank; but the high cost of this equipment makes it necessary to consider alternative sources, such as a motor generator or a resonant magnet circuit working on a reduced duty cycle, to supply higher energy synchrotrons. Mr. Fry concluded his paper with a discussion of the type of resonator which it is proposed to use in the radio-frequency system, in order to minimize eddy current field, the technical problems associated with making the vacuum envelope for the 300 MeV. machine, and the arrangements for obtaining a high injection voltage (about 100 kV.) prior to betatron acceleration.

Prof. Sayers's paper began with a summary of the measurements by Kenty on the decay of ionization in argon after the sudden interruption of a low-voltage arc. Later measurements by Mohler in cæsium and mercury vapour were similar to Kenty's, in that mechanical commutators were used to interrupt the arc and apply voltages after various intervals to Langmuir probes, by which the electron densities were measured. Sayers used a cathode-ray oscilloscope to measure the current of a Langmuir probe, maintained at an adjustable potential, as a function of time after the interruption of a low-voltage arc in argon. From a series of such measurements the time-variation of the electron (or ion) concentration and the electron temperature could be determined at various places in the tube. The loss of particles by diffusion to the walls was illustrated by graphs showing the concentration as a function of position within the tube at different times; at first the concentration was practically uniform over the greater part of the tube, but this region of uniformity became more and more closely confined around the axis of the tube as time went on. Within this region, loss by diffusion may be neglected, so that the value of α, the coefficient of recombination, may be deduced from the equation $\frac{dN}{dt} = -\alpha N^2$, where N is the number per cubic centimetre of ions of either sign. Sayers found that α varies with electron temperature, but is independent of the pressure over the range 0·1–1·0 mm., as would be expected if the recombination is a two-body process. At an electron temperature of 1,000° K., α for argon is about $6 \cdot 6 \times 10^{-10}$ cm.^{3} sec.$^{-1}$.

In comparing these experiments with theory, Prof. Sayers pointed out that the probability of recombination to the ground state of the neutral atom is likely to be only a small fraction of the total recombination probability and, since the excited states will be roughly hydrogen-like for all atoms, it is not unreasonable to compare calculated values of α for oxygen with the experimental values obtained for argon, mercury and cæsium. The variation of α with electron temperature is as predicted by theory, but the absolute magnitude of α is about five hundred times larger than theory predicts. Observations on recombination in the F region of the ionosphere agree with the laboratory experiments, but considerations of the balance of electron population in interstellar space agree with the theoretical value. In contrast to these unresolved discrepancies concerning the capture of electrons into the whole series of states of the atom, measurements by optical methods of the radiative capture of electrons into individual atomic states seem to agree well with theory.

The discussion which followed centred largely around the question of whether, in the laboratory experiments, it is proper to consider the electrons as being in temperature equilibrium at each instant during the few milliseconds occupied by the decay of the ionization.

In the last paper of the afternoon session, Dr. Hoyle discussed one of the most fascinating problems of astrophysics—the process of synthesizing heavy elements from hydrogen and helium, and obtaining the observed distribution of these elements throughout space. There are two main problems to be considered: first, it is necessary to establish the conditions in which this synthesis can take place, and secondly to determine where, in the universe, these conditions are actually to be encountered. Having considered the very great difficulties involved in any theory which envisages conditions other than those of thermal equilibrium between the different elements, Dr. Hoyle proceeded to discuss the results obtained by applying statistical mechanics to the evolution of the heavy elements. He pointed out that from this point of view nuclear reactions can be treated by applying the well-known properties of statistical assemblies of dissociating gases, together with an equation determining the neutron-to-proton ratio as a function of density. This latter equation shows that both the concentration of free neutrons and the ratio of neutrons to protons increase with increasing density, and that to obtain a proportion of heavy elements in accordance with observation, densities of the order of 10^7 gm. per cm.^{3} are required. It can be shown also that to establish equilibrium between the various elements in a time sensibly less than the age of the universe, the region considered must have a temperature of the order of 10^9 degrees. The central temperatures of normal stars are too low by a factor of about 100, but in the case of those which have collapsed to a small fraction of their initial radius owing to the exhaustion of their hydrogen supply, temperatures of the required magnitude may be encountered. At some stage during the collapse, depending on the angular momentum, which differs widely from one star to another, the rotating spheroid becomes unstable, and material is thrown off into space from its equator. Now the nuclear reactions which would have to take place in order to re-establish equilibrium at the lower temperatures and densities require the emission of energy, so cooling is rapidly accelerated. Dr. Hoyle suggested that a small fraction of the heavy elements formed in a collapsed star remain 'frozen'. Thus, since the amount of material thrown off may amount to 99 per cent of the total mass of the star, such elements may be present both in the material thrown off and in the residual core. Dr. Hoyle connected the super-nova catastrophe with physical conditions inferred from the hypothesis that the Crab nebula represents the remains of a past super-nova.

Among difficulties raised in the course of the discussion was that of accounting for the presence of heavy elements in all known stars, which contain also hydrogen and helium.

THE GIACOBINID METEOR SHOWER, 1946

SEVERAL papers describing British observations of the Giacobinid meteor shower, 1946, were presented at a meeting of the Royal Astronomical Society on December 13, 1946. Special interest was attached to this subject because of the incidence of a shower of such exceptional intensity at a time when the considerable advances made by radar techniques were able to make an important contribution to the observations. Such methods not only enabled estimates of hourly rates to be made without interference due to poor visibility, but also demonstrated how information on certain meteor characteristics can be provided more conveniently and more precisely than is possible by visual meteor watches.

An introductory paper on the visual watch was given by J. P. M. Prentice, director of the Meteor Section of the British Astronomical Association. Although observations were considerably hindered by bad weather, it was possible to obtain a complete curve showing the variation in hourly rate by combining the results of several observers. The shower was of approximately six hours duration, rising steeply to a sharp maximum around 0345 hr., followed by a steep decline. The variation in rates was so rapid that the mean hourly rates, determined by averaging over short periods, are considerably affected by the length of period chosen. The visual observations were averaged over 7–8 minutes, and the maximum hourly rate corrected to a radiant in the zenith was 2250. An allowance for the strong moonlight which prevailed was made by comparing the magnitude distribution with the corresponding distribution during the great shower of 1933, for which the observations of F. de Roy are available. Even when this factor is taken into account, the 1933 shower appeared to be at least twice as rich at all stages in the development as that of 1946. It had been anticipated that the shower would be richer in 1946 since the comet was so much nearer the earth at its node than in 1933, the distances being 135,000 miles in 1946 as compared with 500,000 miles in 1933.

Dr. A. C. B. Lovell then described the radar observations which he made with C. J. Banwell and J. A. Clegg at the University of Manchester. The aerial system, which was adjustable in both azimuth and elevation, provided a narrow radio beam at a wave-length of 4·2 m. An almost continuous watch was maintained for 71 hours between October 8 and 11. The radio echoes were generally recorded by visual observation of the cathode ray tube; but, in addition, a ciné-film was taken at 8 frames per second during the peak period.

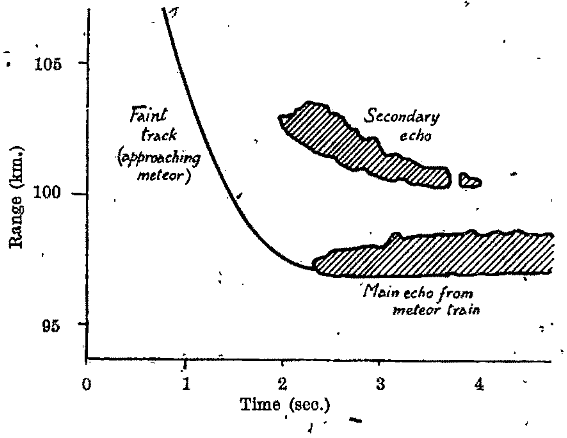
Throughout most of the watch the radio beam was directed at 90° from the Giacobinid radiant. To confirm that echoes are generally only obtained when the beam is perpendicular to the ionized trails produced by the passage of the meteors, the beam was directed towards the radiant for part of the shower, when it was found that the number of echoes fell to 4 per cent of the previous value.

Observations of the hourly rate of occurrence of echoes were made with the directional aerial system, supplemented by a dipole aerial system giving an almost all-round looking beam. Until 2100 hr. U.T. on October 9, the rate was very low, usually 2 per hour and never greater than 6 per hour. A very slight increase was recorded after 2100 hr. U.T.; but it was not until after 0000 hr. on October 10 that the shower suddenly developed. The maximum which occurred between 0340 to 0343 hr. U.T. was extremely sharp, and a peak rate of 168 echoes per minute, averaged over a period of 24 sec., was attained. Within ± 5 min. of this peak the rate was down to 50 per minute, and within ± 30 min. it was 1 per minute. By 0600 hr. the shower had passed completely.

An examination of the life histories of echoes recorded on the ciné-film showed, in a number of cases, very rapid fluctuations in amplitude with a fairly regular decay superimposed. An analysis of the distributions of heights, durations and amplitudes gave evidence of change during the progress of the shower, thus indicating either variation in the characteristics of the stream or in the conditions of the upper atmosphere. The ciné-film record obtained at the maximum of the shower provided a sufficiently accurate distribution of echo amplitude for an estimate to be made of the size distribution of the meteors by means of the theories of meteor ionization developed at the University of Manchester by Herlofson. It was shown that the number of electrons produced per cm. path by the meteor could be determined from the received echo strength, for a radio beam directed at right angles to the meteor train, from the relation

$$\text{received echo power} = 8{\cdot}88 \times 10^{-28}\frac{\alpha^2\lambda^3}{R^3}P_0G^2 \text{ watts},$$

where α is the number of electrons per cm. path, R the range of the echo in cm., λ the wave-length in cm., P_0 the peak transmitter power in watts, and G the power gain of the aerial system (the same for transmitter and receiver) as compared with a half-wave dipole. Calculations by Herlofson showed that α is proportional to the size of the meteor and inversely proportional to the velocity. It was hence deduced from echo-strength measurements during the maximum of the Giacobinid shower that the number of meteors of a given size was inversely proportional to the size.



A visual watch was carried out simultaneously with the radar observation between 0014 and 0107 hr. U.T. and 0134 and 0228 hr. U.T., when the sky was clear; 26 per cent of the radio echoes observed during these periods were coincident with visual meteors. If the analysis is restricted to radio echoes of more than 0·5 sec. duration, then 50 per cent of these were coincident with visual meteors. This simultaneous watch afforded an opportunity of testing Herlofson's theory, according to which a meteor which produces 10^{10} electrons/cm. path will be at the limit of naked eye visibility. This value was found to be in general agreement with that deduced from calculations of the ionization necessary to give the observed radio echoes.

J. S. Hey gave an account of observations made in collaboration with S. J. Parsons and G. S. Stewart, at the Operational Research Group, Ministry of Supply. A continuous watch was maintained during October 7–11, with radar equipment of about 5 metres wave-length, using both visual and photographic recording of the cathode ray tube display. One of the most important results, which emerged as a consequence of improved photographic methods giving better resolution than hitherto, was the recording of the fine structure of the echoes and the determination of meteor velocity. The echoed signals were made to appear as bright spots on a linear-range trace on the cathode ray tube. This was photographed on a film moving at right angles to the trace at uniform speed. The resulting record thus gave a plot of echo-range against time. Satisfactory resolution was obtained by displaying a limited range-band of 80–115 km. over the full width of the cathode ray tube and by using a 35-mm. film moving at 2·4 mm. per sec.

In earlier work by Hey and Stewart (*Nature*, **158**, 481; 1946), it was shown that the main echoes are obtained at right angles to the meteor trails. Some of the recordings in the present series showed clearly that prior to the formation of the main echo there is a faint fast-moving echo which can be associated with the ionization in the immediate vicinity of the approaching meteor. Not until the ionized column approximately reaches the point of intersection of the normal from the observing station to the ionized column can the stronger and more enduring broadside echo be obtained. Secondary reflexions which appeared in the recordings can be attributed to the effects of drifts and diffusion which, as is known from visual meteor data, may cause irregularities in the train a few seconds after its formation. An example of a Giacobinid meteor echo, producing sufficient ionization around it for the track of the approaching meteor to be detected, is illustrated in the accompanying diagram, which is taken from a photographic recording.

These faint tracks resulting from the reflexion from the ionization in close proximity to the approaching meteor enabled the geocentric velocities to be determined without requiring a knowledge of the radiant position. The range–time characteristics, with few exceptions, were found to be representative of a body moving with uniform velocity in a straight line. The range R at any instant T is then given by

$$R^2 = R_0^2 + V^2 (T - T_0)^2,$$

where R_0 and T_0 represent the range and time when the range is a minimum and V is the geocentric velocity. From the analysis of twenty-two tracks, the weighted mean of the computed velocities was found to be 22·9 km./sec., with root-mean-square deviation of 1·3 km./sec., the weighting factor being made proportional to the duration of the track. This mean value is in close agreement with the theoretical velocity of 23·7 km./sec. given by Dr. J. G. Porter, director of the Computing Section of the British Astronomical Association.

Sir Edward Appleton and R. Naismith, who in 1932 noticed the general occurrence of the transient ionospheric radio (or radar) echoes which are now known to arise from the ionization trails of meteors, took part in the discussion. The results which they obtained on the occasion of the Giacobinid Shower of October 10 were described in these columns a few weeks ago (*Nature*, 158, 936; 1946). Moreover, as a result of their systematic study of the diurnal and seasonal variations of both meteor ionization trails and sporadic ionization in the E layer of the ionosphere, they have been led to the important conclusion that the fine dust of sporadic meteors contributes substantially to the irregularities of ionization which have long been known to exist in the E layer. An account of these phenomena, and the descriptions of the investigations of the other radar workers mentioned above and of 60 Group R.A.F., are being given at a meeting of the Physical Society on January 31.

J. S. HEY

NEWS and VIEWS

Gold Medal of the Royal Astronomical Society: Prof. M. G. J. Minnaert

PROF. MARCEL GILLES JOZEF MINNAERT, director of the Sonnenburg Observatory, Utrecht, has been awarded the Gold Medal of the Royal Astronomical Society for his outstanding contributions to solar physics and in particular to solar spectrophotometry. A pupil of Julius, he was later at Utrecht a colleague of Ornstein and Moll, and an early worker in the field of spectrophotometry, both developing the technique and applying it to a wide range of solar problems. He has taken part in a number of eclipse expeditions: to Sumatra in 1926 and 1929, and to Canada in 1932, all spoilt by clouds; his one successful expedition was to Lapland for the eclipse of 1927, where he obtained the first absolute values of the intensities of the chromospheric lines. He produced during the early days of the War a "Photometric Atlas of the Solar Spectrum", a most valuable contribution to solar spectroscopy. His later years in the War were spent in a concentration camp, from which he has emerged with his scientific enthusiasms undamped. He is chairman of the Commission on Spectrophotometry of the International Astronomical Union, a position for which he is well qualified by both experimental and theoretical studies. The distribution of energy in the sun's continuous spectrum and in that of the corona, the law of darkening of the sun's limb, and the polarization of the corona are among other subjects to which he has made valuable contributions. He has also worked on the direct photometry of Venus, the moon and red stars. His work is throughout characterized by a thoroughness, accuracy and care which have secured him a leading position in his own field. He was elected an associate of the Royal Astronomical Society in 1945.

Cadman Medal of the Institute of Petroleum: Mr. R. P. Russell

THE Council of the Institute of Petroleum has awarded the Cadman Memorial Medal to Mr. Robert Price Russell, president of the Standard Oil Development Co., the central technical and research organisation of the Standard Oil Company (N.J.). Great services were rendered by Mr. Russell and his associates during the War in the production of high-octane aviation fuels, synthetic rubbers and toluene for explosives, and in the development of flame throwers, incendiaries and smoke generators. More than half the American output of aviation petrol for war-planes was manufactured by the catalytic cracking process, in which Mr. Russell played a notable part. Nine tenths of the American output of petroleum-based butadiene, the starting material in the manufacture of synthetic rubber, came from the process which Mr. Russell directed into large-scale production. In recognition of his war-time work, Mr. Russell was awarded the Medal for Merit, the highest civilian award in the United States. In 1946 he received the gold medal of the American Institute of Chemists for "noteworthy and outstanding service to the science of chemistry". Mr. Russell is well known personally in Great Britain, for he came here in 1944 as chairman of the Petroleum, Chemical and Rubber Division of the U.S. Strategic Bombing Survey. A team of scientific workers under his supervision entered Germany on the heels of the front-line troops to survey the enemy's vast oil-chemical industry.

Born in Massachusetts in 1898, Mr. Russell saw military service in the First World War; on resuming his studies, he obtained a master's degree in chemical engineering at the Massachusetts Institute of Technology in 1923. After holding some academic appointments, he joined the Standard Oil Co. (N.J.), in 1927, when he became research director of the newly established Esso Laboratories at Baton Rouge, La. Here he initiated research on the hydrogenation process and the manufacture of synthetic products from petroleum. Mr. Russell is now directing research on new and improved uses for crude oil, the production of liquid fuels from coal and natural gas, and the development of improved synthetic rubbers and plastics.

Institution of Electrical Engineers: Honorary Member

THE Council of the Institution of Electrical Engineers has elected Sir John Macfarlane Kennedy, past president, to be an honorary member of the Institution, in recognition of his distinguished work in the sphere of electricity supply and of the services rendered by him to the Institution. Sir John was at Trinity College, Cambridge, and also went to Zurich Polytechnic. He served his pupillage with Richard Moreland and Sons, London, Willans and Robinson, Rugby, and Siemens-Halske, Berlin. During 1902–34 he was a partner in the firm of Kennedy and Donkin, and was engaged in electricity supply, distribution and traction works. In 1922 he submitted to the Electricity Commissioners proposals for the reorganisation of electricity supply in Great Britain, and eventually prepared a report for the Ministry of Transport on the reorganisation of electricity supply. In 1934 he took office with the Electricity Commission, of which he is now deputy-chairman.

Faraday Medal

THE Faraday Medal of the Institution has been awarded to Sir Standen Leonard Pearce, for his outstanding contributions to the advancement of engineering practice and notable achievements in electrical engineering. Sir Leonard Pearce was educated at Bishops Stortford College and Finsbury Technical College, London. He served his pupillage with J. G. Statter and Co. at West Drayton, and Thomas Richardson and Sons of Hartlepool. After occupying various posts, he was appointed in 1903 to be chief engineer to Manchester Corporation Electricity Undertaking; in 1926 he became engineer-in-chief of the London Power Co.

Prof. F. J. W. Roughton, F.R.S.

DR. F. J. W. ROUGHTON, who succeeds Prof. E. K. Rideal in the John Humphrey Plummer professorship of colloid science in the University of Cambridge, is a physiologist admirably qualified to deal with the border-line between biological and physical science. Since his election to a fellowship at Trinity College, Cambridge, in 1923, his researches have been concerned with the carriage of gases by the blood and with the physical chemistry of the blood pigments. His best-known work is that begun with Meldrum on the enzyme carbonic anhydrase, which plays an important part in the transport of carbon dioxide from the tissues to the lungs. Physical chemists will remember also the ingenious methods which he used with Hartridge to study the rapid rate of combination of oxygen with hæmoglobin. Largely as the result of his work, the complex interchanges between the corpuscles and the plasma in the lung capillaries are far more clearly understood. His wide knowledge of physico-chemical techniques and of their application to biological problems has made him an authority in a field which is rapidly becoming one of the growing points in natural science; and physiologists will wish him every success in an appointment which will give full scope to his talent for reducing biological equations to measurable terms.

Human Nutrition at the London School of Hygiene and Tropical Medicine: Prof. B. S. Platt, C.M.G.

THE increasing importance attached to the scientific study of nutrition is reflected in the appointment of Dr. B. S. Platt as professor of human nutrition at the London School of Hygiene and Tropical Medicine. Dr. Platt will continue to hold, in conjunction with the chair, his present post as director of the Medical Research Council's Research Unit of Human Nutrition, at the National Hospital, Queen Square, London. His appointment is thus also another welcome sign of the growing readiness of universities to elect to professorial rank those whose duties are primarily in research; under the old system a professor was too often so fully occupied with teaching as to have little time left for research. Dr. Platt graduated in the School of Chemistry at Leeds in 1923. He engaged in research there under the late Prof. J. B. Cohen, was elected to a Beit Memorial Fellowship in 1926, and became medically qualified in 1930. During 1932–38 he was attached to the Division of Clinical Research of the Henry Lester Institute of Medical Research at Shanghai, as associate in medicine, and in 1932 was the author of the B.M.A. "Bishop Harman Prize Essay" on "The Importance of Vitamin B_1 for Maternal Health in Pregnancy and Lactation". In 1938 he was appointed to the scientific staff of the Medical Research Council, and since 1944 has been director of the Council's Human Nutrition Research Unit.

Dr. Platt has served as a nutritional expert on a considerable number of government committees, including the Scientific Food Policy Committee, the Committee for the Care of Shipwrecked Personnel, the Rations Sub-committee of the Military Personnel Research Committee, and the United Kingdom Delegation to the Food and Agriculture Organisation Conferences; and in his work he has travelled widely, including visits to West and East African territories, Newfoundland and the West Indies. In 1944, he gave the De Lamar Lecture in hygiene at the Johns Hopkins University. He has published a considerable number of papers, dealing mostly with biochemical studies on water-soluble vitamins, his best known work perhaps being that with Miss Lu on the blood pyruvate in vitamin B_1 deficiency in man.

Prof. Frank Horton, F.R.S.

THE recent retirement of Prof. Frank Horton from the University chair of physics which he has held at the Royal Holloway College (University of London) since 1914 brings to an end an active teaching career lasting more than forty years. That career really falls into two parts, Cambridge and London, though it should be mentioned that he received his earlier training at Birmingham, of which University he holds the degree of M.Sc. At Cambridge, as a lecturer at the Cavendish Laboratory in the days of J. J. Thomson, he formed one of that brilliant team of young physicists comparable in their way with those other teams in other spheres during the same epoch, namely, 'Cromer's young men' in Egypt and the Sudan, and 'Milner's young men' in South Africa. An early election to a fellowship of the Royal Society placed a hallmark on the value of his contributions to the field of science in which he specialized.

Prof. Horton went to London in 1914. There, in addition to his teaching and research work, he soon entered into the inner circles of university administration, culminating in 1939 with his election as vice-chancellor. He continued to hold this high and arduous office throughout the War. To quote the words used by the principal of the University in his latest report: "No period of its history was more fraught with danger for the University than these six years, danger not only of physical destruction but of spiritual disintegration. Under the emergency measures which were taken to carry on the work of the University, the Vice-Chancellor was entrusted with wide powers. They were used with the utmost discretion and judgment. Professor Horton enjoyed none of the pomp and pageantry which fall to the lot of the Vice-Chancellor in normal times, but he must surely feel that the widespread and sincere tributes paid to his exceptional services afford some measure of compensation." The Senate, realizing that his term of office as a faculty representative was drawing to a close, paid tribute to the debt which it owed to his services by electing him as one of its co-opted members.

National Institute of Sciences of India: Elections

THE following have been elected ordinary fellows of the National Institute of Sciences of India: Mr. S. Basu, deputy director general (forecasting), Poona, distinguished for his work in weather forecasting; Dr. U. P. Basu, chief chemist, Bengal Immunity Co., Ltd., Calcutta, distinguished for his work in chemotherapy; Mr. J. Coates, senior geologist, Burmah Oil Co., Ltd., Digboi, distinguished for his work in geology; Dr. G. Krishnamurti, assistant director, Department of Chemotherapy, Haffkine Institute, Bombay, distinguished for his work on Indian medicinal plants; Dr. B. S. Kadam, Central Tobacco Research Station, Guntur, distinguished for his work in genetics and plant breeding; Prof. D. D. Kosambi, professor of mathematics, Tata Institute of Fundamental Research, Bombay, distinguished for his work in path geometry and statistics; Mr. V. Khanolkar, director of laboratories, Tata Memorial Hospital, Bombay, distinguished for his work in human pathology; Dr. D. R. Malhotra, B.B. and C.I. Railway, Ajmer, distinguished for his work in metallurgical chemistry; Dr. B. Mundkur, mycologist, Imperial Agricultural Research Institute, New Delhi, distinguished for his work in systematic mycology; Dr. B. Narayana, professor of physiology, Prince of Wales Medical College, Patna, distinguished for his work in physiology; Dr. B. P. Pal, economic botanist, Imperial Agricultural Research Institute, New Delhi, distinguished for his work in genetics and plant breeding; Dr. V. G. Panse, statistician, Institute of Plant Industry, Indore, distinguished for his work on the application of statistical methods of plant breeding; Dr. P. B. Sarkar, senior research chemist, Indian Central Jute Committee, Calcutta, distinguished for his work on the chemistry of jute; Dr. B. N. Srivastava, Physics Department, University of Allahabad, distinguished for his work in thermodynamics; Dr. L. C. Verman, director of physical laboratories, Council for Scientific and Industrial Research, Delhi, distinguished for his work in applied physics.

Geological Society Awards

THE Council of the Geological Society announces the following awards:

Wollaston Medal to Dr. Joseph Burr Tyrrell, for his services to geological science in the Dominion of Canada, more particularly his pioneer work on the Barren Lands west of Hudson Bay and on the goldfields of Klondyke and Kirkland Lake.

Murchison Medal to Mr. Percy Evans, in recognition of his researches on the oilfields of Burma and Assam, and his work on the geological interpretation of gravitational surveys.

Lyell Medal to Dr. Stanley Smith, for his researches on Palæozoic corals, particularly their structure and relationships, and for his investigations into Lower Palæozoic and Carboniferous stratigraphy.

Bigsby Medal to Dr. George Hoole Mitchell, for his geological investigations in the Lake District and his work on the coalfields of Yorkshire and the Midlands.

Wollaston Fund to Dr. Austin William Woodland, for his work on the Cambrian rocks of Merionethshire and on the water supply of the Midlands and East Anglia.

Murchison Fund to Dr. Duncan Leitch, in recognition of his studies of the Carboniferous stratigraphy of Scotland and his investigations of the lamellibranch faunas of the Scottish coalfields.

A moiety of the Lyell Fund to Dr. Leslie Rowsell Moore, for his investigations of Upper Carboniferous faunas and floras of the Bristol, Somerset and South Wales coalfields; another moiety of the Lyell Fund to Mr. Claude William Wright, for his work on the faunas of the Cretaceous rocks of southern England and the Yorkshire and Lincolnshire wolds.

Physical Society's Proposed Acoustics Group

A MEETING of those interested in the formation of an Acoustics Group of the Physical Society will be held in the Jarvis Hall of the Royal Institute of British Architects, 66 Portland Place, London, W.1, at 3 p.m. on February 19. Mr. H. L. Kirke, head of the B.B.C. Research Department, will be in the chair, and Dr. Alex Wood will give an address on "The Contribution of Acoustical Science to Allied Studies". It is hoped to arrange an informal exhibition of recent acoustical apparatus. The agenda for the meeting will include a general discussion of the proposal to form such a group, the election of a chairman and officers, and the adoption of a set of rules. Those interested should send their names, indicating whether they will be able to attend the meeting, to the acting secretaries, Mr. A. T. Pickles and Mr. W. A. Allen, at the office of the Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Recenti Progressi in Medicina

THE appearance of the first issue (dated October 1946) of *Recenti Progressi in Medicina*, a monthly review of international medical and surgical literature, published in Rome under the directorship of Giuseppe Lazzaro, supported by some twenty-eight collaborators, is an interesting development of post-war medical activity in Italy. This first issue, which owes much to the advice and experience of Prof. Giuseppe Bastianelli, to whom the editor pays a warm tribute, is mainly devoted to a review of recent progress in our knowledge of the various types of inflammation of the lungs. It deals not only with the types of pneumonia caused by bacteria, but also with influenzal pneumonia, coccidiomycosis, *Q*-fever and psittacosis. An especially long and detailed section, illustrated by X-ray photographs, deals with primary atypical pneumonia. Another article is devoted to the condition known to some as infiltration of Hegglen or pneumonia associated with a positive Wassermann reaction. Treatment of the pneumonias with penicillin and sulphonamides is the subject of another article, and there are abstracts from literature dealing with other aspects of the study of inflammation of the lungs. A short section records two immunological laboratory procedures. A bibliographical section consists entirely of the contents of the *British Medical Journal* during the months January to April 1946.

The next issue of this journal will be devoted to recent progress in the treatment of disease with penicillin, and will contain articles by Sir Alexander Fleming and Sir Howard Florey, the translation of these two articles having been aided by the British Council. The editors offer a special word of thanks to the British Council and to the president of the Medical Section of American Relief in Italy for the help given to them in the publication of the journal. British and American sources predominate in the first issue. Future numbers will be awaited with interest. The journal should do much, not only to bring Italian medical men the latest information on a wide variety of subjects, but also to promote co-operation between them and medical men in other countries.

Trees Used for Animal Fodder in India

INDIAN FOREST LEAFLET No. 82 (Sylviculture) (Forest Research Institute, Dehra Dun. Pp. iv+17. 8 an.) discusses those trees the foliage of which is used for animal fodder in India. It is the third edition of a small publication written by M. V. Laurie, then sylviculturist at the Forest Research Institute, Dehra Dun, first issued in 1939. It was quickly sold out, as also was the second edition, the present being a revised third edition. India has been one of the countries the population of which has been much addicted to tree lopping, usually to provide forage for animals. With the appearance of the Animal Husbandry Wing of the Agricultural Research Council in India, a start was made in collecting information on the subject of fodder grasses and general fodder supplies. It was left to the Forest Research Institute at Dehra Dun to institute inquiries into the trees used for this purpose—and used very often to the detriment of the forests so maltreated. The list does not make any claim to scientific accuracy, but merely represents the consolidated opinions of forest officers throughout India of the relative popularity of different trees for lopping for fodder.

British Council Scholarships, 1946–47

FOR the current academic year, 248 graduates and others of like status from overseas have been awarded British Council scholarships, which enable them to take a wide range of post-graduate courses of study in British universities and similar institutions. The scholarships are normally for one year, but extensions are granted in suitable cases. In addition, the Council has helped to place many students who have come to Britain under the auspices of overseas authorities or privately. The Council has this year established a Students' Welfare Department to deal with the reception and non-academic welfare of scholarship holders, and to help them to gain a general knowledge of British life and institutions. To this end vacation courses, which enable those residing in London to visit the provinces and vice-versa, as well as term-time talks, discussions, shows of documentary films and other events are arranged. These facilities are available also to students sponsored by the Colonial Office, the Indian and Sudan Governments, and to other overseas students. Scholarship holders this year have come from some fifty Empire and foreign countries. The awards are for various subjects, including agriculture and agricultural sciences (6), engineering and mining (15), sciences and technology (50).

Spectrochimica Acta

AN international medium for the publication of research results in applied spectroscopy was launched in 1939, and published by Julius Springer in Berlin until 1944. This is being revived under the joint editorship of several spectroscopists, as before. The editorial board will consist of: Dr. A. Gatterer (Vatican Observatory), Mr. E. van Someren (London), Prof. R. Breckpot (Louvain), Dr. W. Gerlach (Munich), Dr. H. Kaiser (Jena) and Dr. L. W. Strock (Saratoga Springs). The first number of the third volume should appear early in 1947, and authors of papers on emission or absorption spectroscopy are invited to submit manuscripts, in English, French, German or Italian, to the nearest member of the editorial board. Publication should be fairly prompt, by current standards. As in most scientific publications, authors are urged to be concise; but the paper supplies are sufficient to allow each author 75 reprints. The printing will be undertaken by the printers in the Vatican City, who are accustomed to dealing with a variety of languages. Authors in Great Britain should communicate with Mr. E. van Someren, 20 Churchfields, Broxbourne, Herts.

Announcements

THE Medical Research Council has appointed Dr. S. T. Cowan (formerly of the University of Manchester) to succeed Dr. R. St. John Brooks as director of the National Collection of Type Cultures of Micro-organisms. The Collection continues to be housed at the Elstree establishment of the Lister Institute of Preventive Medicine, but will be moved to the Central Public Health Laboratory at Colindale as soon as accommodation there is available.

MR. J. B. BENNETT has been appointed to succeed the late Mr. W. Barnicot as secretary of Rothamsted Experimental Station.

IN accordance with its usual practice, Trinity College, Cambridge, announces the offer of a research studentship open to graduates of other universities who propose to go to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be as much as £300 a year. Candidates must not have reached the age of twenty-six before May 1 (length of war service can be added). The College also offers, as usual, exhibitions of the value of £40 to students of Dominion and Colonial universities who wish to go to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. A candidate for a studentship or exhibition should apply through the principal authority of his university, and his application must reach the Senior Tutor, Trinity College, Cambridge (from whom further particulars may be obtained), by May 1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Ethical Aspects of the Development of Atomic Energy

When I read the editorial article in *Nature* of December 21 on "Ethical Aspects of the Development of Atomic Energy" I had not seen "Programme for Survival" by Prof. Lewis Mumford, reviewed in that article. I have now obtained and read it—with surprise; for you say "Unconditional co-operation, Prof. Mumford holds, is the price of mankind's survival; and he sets that as the objective, urgent and imperative, but not to be attained unilaterally or forthwith as Mr. Lionel Curtis is inclined to suggest". Yet on p. 4, Prof. Mumford writes, "We must think swiftly, plan swiftly, act swiftly". I am all the more puzzled because the article in *Nature* had noted that "Prof. Mumford is as insistent as scientific men themselves that we have only a limited time in which to learn the art of control and to prevent the suicidal misuse of scientific knowledge".

Reference is made to the report of scientific men transmitted on June 11, 1945, to the Secretary of War at Washington, and they are reported as urging that "the political problems arising from the mastering of nuclear power should be recognized in all their gravity, and that appropriate steps should be taken for their study and for the preparation of the necessary decisions. The existence of nuclear weapons is regarded as the most compelling argument calling for an efficient international organisation for peace."

The date of this report is significant. Before the atomic bombs had been dropped on Japan its inventors had realized the need to establish an international organisation powerful enough to control their terrible weapon and were warning their political chief in advance. They, at any rate, did not regard advice to postpone the creation of such an authority as a counsel of wisdom.

It is rightly said that Prof. Mumford wants the world "to wait a decade if need be before the harnessing of atomic energy to peaceful purposes proceeds apace".

But soldiers, industrialists and rulers are not going to wait because we wish them to wait. The *Nature* article continues: "The future of humanity depends, as Prof. Mumford asserts, on the three great Powers, not less than others, placing themselves strictly under the judgment and the surveillance of the rest of the world. . . . 'The authority of the United Nations must be unqualified and universal; every last laboratory and factory must be open to investigation by authorized international agents, responsible to the central world authority. The power to spread, limit or even outlaw scientific investigation must reside in such a body no less than the power to outlaw completely all national armies. Privacy, secrecy, sovereignty must be unconditionally surrendered to a common body whose prescribed powers must override all local administrative organs at every point that is necessary to ensure freedom from fear and freedom from unlawful aggression.'"

To all this no one could agree more fervently than I. But things like this are not to be done by mere wishing or by words, however eloquent. They can only be done, to quote the *Nature* article, by bringing "the fact-finding method of science into the political sphere as a step towards the elucidation of policy 'and measures'", or in the words of the report of the scientific men quoted above: "the political problems arising from the mastering of nuclear power should be recognized in all their gravity, and appropriate steps should be taken for their study and for the preparation of the necessary decisions".

I quote this last passage because this exactly was done by the Leave Groups of men and women of all ranks from the Forces of all the United Nations who met every week in Balliol College, Oxford, for the last three years of the War. Some three thousand passed through these groups all inspired by the purpose of working out some plan for an international democracy strong enough to save their children from a third World War, from such horrors as they were facing in the Second World War and their fathers had faced in the First. It was my privilege to lead their discussions. The results hammered out week by week are fully stated in "World War; its Cause and Cure", and more shortly in "War or Peace?". I think Prof. Mumford would take heart if he studied these records and realized how far effect had already been given to methods advocated in the American report you quote, and also in your own article. These results are now known as the Leave Groups policy, a policy in the real sense of the word. But a policy, however carefully framed, is not by itself enough. I think Prof. Mumford sees this when he says "It is a question of dynamic will-power", though I prefer the simpler words "of leadership", such leadership as Mr. Winston Churchill gave us in 1940 and throughout the War. Field-Marshal Smuts saw this in his great speech at The Hague—when he called on Britain to lead the democracies, impotent as they now are, to strength and the safety that strength alone can give. My own comment on this was that a nation can lead other nations only in so far as it is itself led by one of its own recognized leaders.

Since the *Nature* article appeared on December 21, Mr. Winston Churchill has published his two momentous articles in the *Daily Telegraph* of December 30 and 31 entitled "The Way to Stop a New War". His thought seems to have led him to the same conclusions as those reached in the Leave Groups after three years of discussion. Let me quote his significant words. "One spasm of resolve! One single gesture! The prison doors clang open. Out walk, or totter, the captives into the sunshine of a joyous world. I do not at all conceal from the reader that an act of the Sublime is required. It is a very simple act, not even a forward bound. Just stand erect, but all together. . . . If we cannot get all countries, we must get all we can; and there may be many. . . . It may well be that everybody cannot join the club at once. The beginning must be made. The nucleus must be formed in relation to the structure as a whole, so that others can join easily as soon as they feel inclined or feel able. The ideal is so commanding that it can afford a gradual realisation.

"Of all the deterrents against war now acting upon the minds of men, nothing is comparable to this frightful agency of indiscriminate destruction. While this supreme weapon rests in the hands of the United States alone, it is probable, though we cannot say it is certain, that a breathing space will be accorded to the world. We cannot tell how long this breathing space will last. Let us make sure that it is not cast away. If, in this interval we can revive the life and unity of Europe and Christendom, and with this new reinforcement build high and commanding a world structure of peace which no one dare challenge, the most awful crisis of history will have passed away and the high road of the future will again become open. . . . If during the next five years we can build a world structure of irresistible force and inviolable authority, there are no limits to the blessings which all men may enjoy and share."

Mr. Churchill makes it clear that in our own country this must be the work of both parties, for he tells us that "Mr. Attlee has declared 'Europe must federate or perish' and he does not readily change his opinions".

So since the *Nature* article was published the leadership to action which we needed and for which we have waited so long has been given.

LIONEL CURTIS

All Souls College, Oxford.
Jan. 13.

Nuclear Disintegration by Meson Capture

RECENTLY, multiple nuclear disintegration 'stars', produced by cosmic radiation, have been investigated by the photographic emulsion technique. Plates coated with 50 µ Ilford B.1 emulsions[1] were exposed in aircraft for several hours at 30,000 ft. One of these disintegrations was of particular interest, for whereas all stars previously observed had been initiated by radiation not producing ionizing tracks in the emulsion, the one in question appears to be due to nuclear capture of a charged particle, presumably a slow meson.

The star consists of four tracks *A*, *B*, *C* and *D* (Fig. 1). *A*, *B* and *D* lie almost in the plane of the emulsion, whereas *C* dips steeply (at about 40°) and ends in the glass. *D* is due to a proton of energy 3·7 MeV., and *C* also corresponds to a proton, of more than 3 MeV., and most likely about 5 MeV. Track *B* was most probably produced by a triton of 5·6 MeV. A short track, about 1 µ long, between *A* and *B* is apparently due to the residual recoil nucleus.

Track *A* appears to enter the emulsion surface about 150 µ from the star centre. On account of the relatively large distances between consecutive grains at this range, the track cannot be distinguished at all easily against the spontaneous background of grains, and only the last 100 µ of track (below arrow) can be traced with certainty. Assuming it to be singly charged, the mass of the particle producing track *A* has been roughly evaluated by the following methods.

(1) Both ionization and scattering increase towards the origin of the star, hence the particle was definitely travelling *towards* the disintegration point.

An electron is discounted because the observed ionization is far too high (an electron track of this range would, in fact, not be detected at all), and the scattering too small. On the other hand, a proton is discounted since the observed scattering is too great (Fig. 2). We must, therefore, conclude that the particle had a mass intermediate between that of electron and proton.

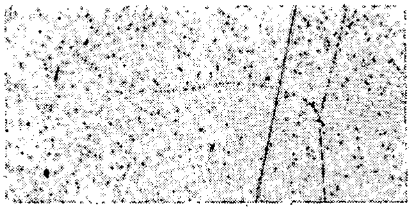


Fig. 1 *a*. PHOTOMICROGRAPH OF CENTRE OF STAR, SHOWING TRACK OF MESON PRODUCING DISINTEGRATION. (LEITZ 2 MM. OIL-IMMERSION OBJECTIVE. × 500)

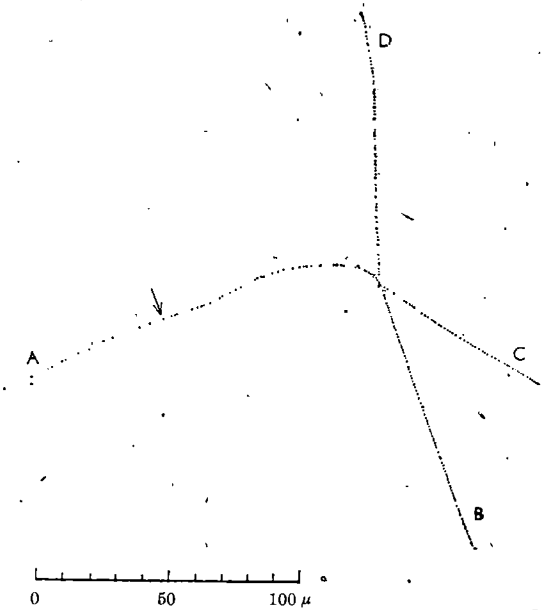
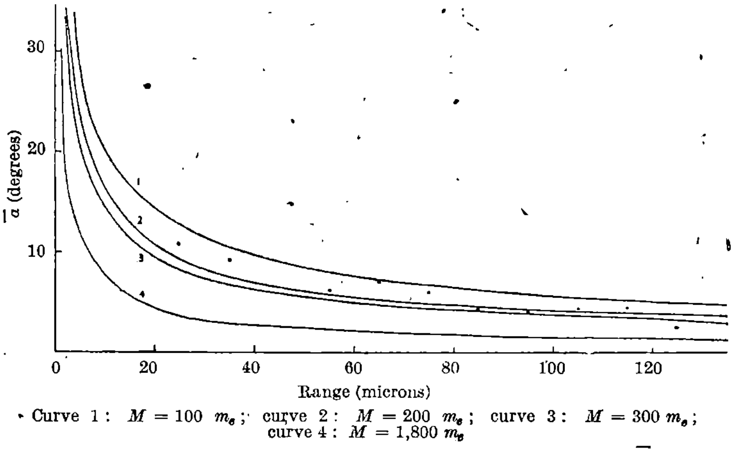


Fig. 1 *b*. TRACE OF COMPLETE STAR ON SCREEN OF PROJECTION MICROSCOPE, SHOWING PROJECTION OF THE TRACKS IN THE PLANE OF THE EMULSION. TRACK *A* CANNOT BE TRACED WITH CERTAINTY BEYOND THE ARROW

The grain density along track *A* does, in fact, agree well with that to be expected of a meson of the observed range of about one tenth of the proton mass. The range-energy curve for mesons in the emulsion has been obtained from that for protons (kindly lent by Dr. C. F. Powell), using the ratio of the masses of the two particles.



Curve 1 : $M = 100\ m_e$; curve 2 : $M = 200\ m_e$; curve 3 : $M = 300\ m_e$; curve 4 : $M = 1{,}800\ m_e$

Fig. 2. MULTIPLE SCATTERING OF MESONS AND PROTON IN THE EMULSION. $\bar{\alpha}$ DENOTES THE MEAN ANGLE OF SCATTERING FOR A 10 µ LAYER OF THE EMULSION. CURVES CALCULATED FOR PARTICLES OF MASS 100 m_e, 200 m_e, 300 m_e AND 1,800 m_e (PROTON), m_e BEING THE ELECTRON MASS. EXPERIMENTAL POINTS, FROM MEASUREMENTS ON TRACK *A*, INDICATED BY DOTS

(2) The elastic scattering of mesons and protons can be calculated from the known emulsion constitution, using Williams's formula[2] for the mean square angle of multiple scattering, and is shown plotted against range in Fig. 2. Bearing in mind the fact that the single scattering will introduce large fluctuations, the experimental points appear to be consistent with a meson mass between 100 m_e and 300 m_e, m_e being the electron mass. Only the horizontal projection of the scattering along the track can actually be measured; on the average, multiplying this by a factor $\sqrt{2}$ will give the true value. The scattering of fast electrons cannot be found from any simple formula, but it is certainly much greater than the observed values.

(3) A value of the meson mass can also be arrived at from the energy required in the nuclear disintegration. In this process, the emitted particles must have sufficient energy to surmount the potential barrier, so that the disintegrating nucleus in this case cannot be that of silver or bromine, and must, therefore, be either carbon, oxygen or nitrogen (in the gelatin).

An approximate calculation of the momentum of the recoil nucleus indicates that at least one neutron must be postulated to conserve momentum; the kinetic energy of this neutron must be around 4 MeV. If we assume that a negative meson is captured by a nucleus nearly at the end of its range and is annihilated, so that the rest energy of the meson becomes nuclear excitation energy, we could have disintegration schemes such as

$$Y^- + \mathrm{O}^{16}_{8} \to \mathrm{N}^{16*}_{7} \to \mathrm{H}^{3}_{1} + 2\mathrm{H}^{1}_{1} + n^{1}_{0} + \mathrm{Be}^{10*}_{4}$$
$$(\text{or } 2n^{1}_{0} + \mathrm{Be}^{8}_{4})$$
$$Y^- + \mathrm{N}^{14}_{7} \to \mathrm{C}^{14*}_{6} \to \mathrm{H}^{3}_{1} + 2\mathrm{H}^{1}_{1} + n^{1}_{0} + \mathrm{Li}^{8*}_{3}$$
$$Y^- + \mathrm{C}^{12}_{6} \to \mathrm{B}^{12*}_{5} \to \mathrm{H}^{3}_{1} + 2\mathrm{H}^{1}_{1} + n^{1}_{0} + \mathrm{He}^{6*}_{2}$$

As the recoil nucleus would be expected to have a fairly high excitation energy (5–10 MeV.) above the ground-state, it must be relatively stable against further disintegration into charged particles. With this limitation, there are still a large number of possible reactions (considering all isotopes of carbon, oxygen and nitrogen), but it appears that in general the mass excess of the recoil nucleus $\sim$ 15 MeV., whereas that of the initial one $\sim$ 5 MeV. or less. The negative Q value of the reaction, allowing for excitation energy, is then found to be $\sim$ 60 MeV., and the total kinetic energy of the ejected particles $\sim$ 20 MeV. The total excitation energy of the original nucleus would then be $\sim$ 80 MeV., probably with an error of ± 20 MeV. (to allow for the various numbers of neutrons emitted, etc.).

On the above hypothesis, the meson should, therefore, have a rest energy of 60–100 MeV., that is, a mass of between 120 m_e and 200 m_e.

Near the end of the meson track, a small number of grains are observed slightly off the main track. If these are due to fast secondary electrons, their ranges appear to be considerably greater than would be expected from the energy of the primary.

I am indebted to the A.O.C., Royal Air Force, Benson, Oxon., for kindly exposing the plates.

D. H. PERKINS

Imperial College of Science and Technology,
London, S.W.7.
Jan. 8.

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[1] Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, 23, 102 (1946).
Williams, *Proc. Roy. Soc.*, A, 169, 531 (1938).

Angular Distribution of Protons Ejected in the Disintegration of Nitrogen by α-Particles

USING a powerful polonium source and an especially well-defined geometry, we have recently obtained 850 expansion-chamber photographs showing 90 proton tracks produced on the disintegration of nitrogen by α-particle bombardment. Our arrangement, therefore, gave on the average one disintegration for every ten photographs, thus greatly reducing both the expense of the photographic materials used and the labour of the examination of the photographs.

The number of disintegrations decreases rapidly as the energy of the α-particles is reduced, but the photographs show that disintegrations occur quite definitely for energies less than 1·7 MeV., and probably at energies less than 1 MeV.

The angular distribution shows a marked change with energy. For α-particles of energy less than 3 MeV., the distribution is almost uniform in numbers between 30° and 120°, while at 3·5 MeV. there is a marked preponderance at about 90° with proportionately smaller numbers of protons ejected symmetrically at angles greater and less than this value. It is interesting to recall that the well-known disintegrations recorded by Blackett and Lees[1] for 3–4 MeV. α-particles in nitrogen both show the ejection of the proton in the neighbourhood of 90°.

A full report of the experiment, together with selected photographs, will be published elsewhere.

F. C. CHAMPION
R. R. ROY

Wheatstone Laboratory,
King's College,
London.
Dec. 10.

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[1] Blackett, P. M. S., and Lees, D. S., *Proc. Roy. Soc.*, A, 136, 325 (1932).

A Revised Estimate of the Age of the Earth

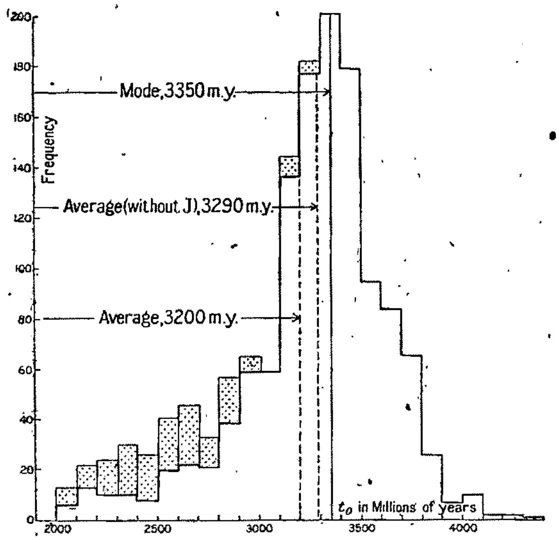
SINCE the publication of my preliminary account of a new method of estimating the age of the earth[1], based on Nier's isotopic analyses of samples of lead from galena and other lead minerals of known geological age, I have revised the calculations, using Glaisher's Exponential Tables[2], and greatly increased the number of solutions. 1,419 solutions for t_0 (the time since the isotopic constitution of the earth's primeval lead began to be modified by additions of lead isotopes generated from uranium I, actinium U and thorium) and for x and y (the respective isotopic abundances of Pb^{206} and Pb^{207} in primeval lead) have been obtained from the following combinations of data (Table 1). The numbers are those of the lead samples as listed in the original article[1], and the italicized figures in brackets are the approximate ages in millions of years (t_m) of the parental lead minerals.

TABLE 1

Number of lead sample	Combined with Nos.	and also with Nos.
25 (Great Bear Lake, *1330*)	1, 2, 3, 5, 6 (*25*[illegible])	19 and 21
23 (Broken Hill, N.S.W., *1200*)	7 (*60*)	19 and 21
22 (Broken Hill, N.S.W., *1200*)	9 and 11	19 and 21
21 (Quebec, *800*)	(Joplin, *100*)	19
19 (Ivigtut, *600*)	13–18 (*220*)	—

together with combinations of each of the above five sets with the others.

The data for six samples have not been used: either because the ages of the parent minerals are unknown or because the constitutions of the leads are so abnormal as to give highly discordant and mutually divergent results.



HISTOGRAM REPRESENTING THE FREQUENCY DISTRIBUTION OF 1,419 SOLUTIONS FOR t_0 WITHIN RANGES OF 100 M.Y. THE FREQUENCIES OF 162 SOLUTIONS (J) INVOLVING THE JOPLIN LEADS, NOS. 9 AND 11, ARE INDICATED BY DOTTING. THE HISTOGRAM FOR 1,257 SOLUTIONS (WITHOUT J) IS INDICATED BY BOLD LINES

As shown by the accompanying histogram, the solutions for t_0 now range from 2,000 to more than 4,000 m.y., but have a marked concentration around 3,350 m.y. A few additional results fall below 2,000 m.y., but as these are inconsistent with the ages of the oldest known rocks, and give impossibly high values for x and y, they have been neglected. The relatively narrow range of the solutions for t_0 originally published[1] (2,700–3,150 m.y.) was due, partly to the limited number of solutions then completed, partly to an early work-sheet error in copying Nier's figure for the isotopic abundance of Pb^{206} in the Joplin lead No. 11. This mistake did not affect the estimate of t_0 which was finally adopted, but it made it appear that the solutions involving the Joplin data were in far better agreement with those not involving the Joplin data than they actually are.

It is now clear, as originally suspected, that the Joplin samples of lead are all of abnormal isotopic constitution. The solutions involving Joplin data are indicated separately in the histogram, in order to bring out the facts (*a*) that they all lie on the left-hand side of the frequency maximum or mode; (*b*) that the histogram becomes much less skew without them; and (*c*) that the mode itself is independent of the Joplin solutions.

The new average and modal solutions, together with the original one, are listed in Table 2.

TABLE 2

	Original solution (Holmes, 1946[1])	Average of 1419 solutions (including J*)	Average of 1257 solutions (excluding J*)	Modal solution (see Fig.)
Age of earth (in m.y.)				
t_0.	3000	3200	3290	3350
Primeval lead ($Pb^{204} = 1$)				
x (Pb^{206})	12·50	11·20	11·04	10·945
y (Pb^{207})	14·28	13·70	13·61	13·51
Sum of squares of 'age anomalies' (see Table 3)	686,500	138,125	66,725	58,900
Sum of squares (including J* anomalies)	933,000	281,775	270,375	265,475

* 'J' refers to solutions involving the Joplin leads Nos. 9 and 11.

TABLE 3

Test of modal solution: $x = 10·945$; $y = 13·51$; $t_0 = 3350$ m.y.

No. of lead sample	Excess Pb^{206} $(a-x)$	Excess Pb^{207} $(b-y)$	$r = \frac{b-y}{a-x}$	t'_0 (m.y.)	'Age anomalies' +	−
1	7·905	2·15	0·2720	3350	0	0
2	7·725	1·94	0·2511	3220		130
3	7·455	2·02	0·2710	3340		10
5	7·125	1·89	0·2653	3310		40
6	7·765	2·19	0·2820	3405	55	
7	8·355	2·22	0·2657	3300		50
13	7·155	2·06	0·2879	3380	30	
14	7·255	1·95	0·2688	3270		80
15	6·415	1·95	0·3040	3470	120	
16	7·515	2·15	0·2861	3370	20	
17	7·005	2·06	0·2941	3415	65	
18	7·485	2·10	0·2806	3340		10
19	3·705	1·14	0·3077	3360	10	
21	5·325	1·65	0·3099	3310		40
22	5·125	1·89	0·3688	3425	75	
23	4·985	1·78	0·3571	3360	10	
25	4·985	1·79	0·3591	3315		35
					+385	−395

Sum of squares of 'age anomalies' = 58,900

The relative merits of the above solutions can be tested by a 'least square' method, as illustrated in Table 3, which refers to the modal solution. Knowing a and b (the relative atomic abundances of Pb^{206} and Pb^{207} in each sample of lead) and adopting the modal values for x and y (Table 2), we have:

$$r = \frac{\text{No. of atoms of } Pb^{207} \text{ generated from } t_0 \text{ to } t_m}{\text{No. of atoms of } Pb^{206} \text{ generated from } t_0 \text{ to } t_m} = \frac{b-y}{a-x}.$$

The values of r for various assigned values of t_0 can be computed for each appropriate value of t_m from the formula

$$r = \frac{1}{139} \cdot \frac{e^{t_0 \lambda \mathrm{AcU}} - e^{t_m \lambda \mathrm{AcU}}}{e^{t_0 \lambda \mathrm{UI}} - e^{t_m \lambda \mathrm{UI}}},$$

and for each value of t_m a curve can be drawn showing the variation of r with t_0. From the resulting family of curves the value for t_0 (distinguished as t'_0 in Table 3) corresponding to each value of r in Table 3 can be easily read off.

Ideally, t'_0 should be 3,350 m.y. in each case. The differences between 3,350 m.y. and t'_0, which may be called 'age anomalies', are given in the last two columns. As between the four solutions summarized in Table 1 the 'best' solution should be the one for which the sum of the squares of the 'age anomalies' is a minimum. The results, given in the last line of Table 2, show that the modal solution is slightly better than the average solution without Joplin results; that both are better than the average solution with Joplin results; and that all three are far superior to the preliminary solution originally announced. Moreover, beyond $t_0 = 3{,}350$ m.y., the sums of the squares again begin to increase; for example, a group of solutions averaging $t_0 = 3{,}475$ m.y. gives 61,775 and 297,350 for the respective sums (cf. Table 2). It is, therefore, concluded that, on the evidence at present available, the most probable age of the earth is about 3,350 million years.

ARTHUR HOLMES

Grant Institute of Geology,
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[1] Holmes, A., *Nature*, 157, 680 (1946).

[2] Glaisher, J. W. L., *Camb. Phil. Trans.*, 13, 243 (1877).

Shift of Aromatic Band in Substituted Benzene

THE aromatic band[1] found in benzene at 671 cm.$^{-1}$ shifts as a consequence of mono-substitution (in benzene) to 740–760 cm.$^{-1}$. In the case of di-substituted benzenes, there is a steady movement to higher frequencies in passing from the ortho- to the para-position; whereas in the case of para-substituted phenols we find that increase in molecular weight of the para-substituent from methyl to octyl does not shift the absorption band, which is found in all these compounds at 825–830 cm.$^{-1}$. Less extensive data on the ortho-phenols show no drift in the aromatic band at 750–755 cm.$^{-1}$ as a result of change in the molecular weight of the substituent from methyl to isopropyl. *m*-Cresol and *m*-ethyl phenol absorb strongly at 780–785 cm.$^{-1}$. It would appear that increasing molecular weight by aliphatic substituents does not shift the aromatic band in the mono-substituted phenols.

In the case of di-substituted phenols the following data were obtained:

1 : 2 : 5	$OH : CH_3 : CH_3$	800 cm.$^{-1}$.
1 : 2 : 5	$OH : C_2H_5 : CH_3$	815 ,,
1 : 3 : 5	$OH : CH_3 : CH_3$	830 ,,
1 : 3 : 5	$OH : CH_3 : C_2H_5$	850 ,,

While the shift of the aromatic band, as a result of a change from methyl to ethyl in one of the two substituents of phenol, is rather more, especially in the case of the 1 : 3 : 5 derivatives, than in the case of the mono-substituted phenols, it should be noted that Whiffen and Thompson's data show a shift of 15 cm.$^{-1}$ in moving from methyl to ethyl in the case of mono-substituted benzenes, and a shift of 36 cm.$^{-1}$ in the case of *p*-xylene and *p*-ethyl toluene. Finally, in the case of 1-hydroxy 2 : 3 : 5 methyl benzene, the aromatic band is found at 840 cm.$^{-1}$. Comparison of this tetra-substituted benzene with the related tri-substituted benzenes is given below:

1 : 2 : 3	$OH : CH_3 : CH_3$	770 cm.$^{-1}$.
1 : 2 : 5	$OH : CH_3 : CH_3$	800 ,,
1 : 3 : 5	$OH : CH_3 : CH_3$	830 ,,
1 : 2 : 3 : 5	$OH : CH_3 : CH_3 : CH_3$	840 ,,

It is evident that adjacency of substituents and degree of substitution affect the shifting of the band, to a greater extent in general than increase in molecular weight of the substituent.

I am indebted to Mr. J. S. M. McKee, who carried out the experimental work.

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Nov. 29.

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[1] Whiffen and Thompson, *J. Chem. Soc.*, 268 (1945).

Rate of Growth of Current in Arc Discharges

IF a condenser, charged to a few hundred volts, is connected directly across a small two-electrode tube containing rarefied gas, and a discharge initiated by applying a high-tension triggering pulse near the cathode, the condenser will be discharged in a few microseconds. The discharge is a form of arc, since a 'cathode spot' is necessary to supply the very high currents (a thousand amperes or more) needed to do this, and the applied potential is lower than that associated with glow or spark discharges.

These arcs have been used by many investigators[1] in order to obtain photographs of rapidly moving objects; but a study of the factors within the tube which determine the rate of growth of current seems to have been neglected.

As a result of such a study I have reached the following conclusions about the early stages (that is, the first microsecond) of the discharge. The current density of emission from the cathode spot is greater than 10^6 amp. per sq. cm., and this emitting area generally races over the surface of the cathode at such a velocity that it moves on to new territory in about 10^{-7} sec. Even at such an emission current density, the cathode does not become unduly heated because of the velocity of the spot; thermionic emission is thus very unlikely.

This current density is sufficiently high for field emission to be the most probable cause of the electron current from the cathode. On this assumption one might expect the current in the tube to rise as rapidly as positive ions can be created and carried to the cathode from the 'positive column' close to it. Nearly all the applied potential appears to be taken up by this column. The rate of growth of current is, in fact, found to be greater for a residual gas the ionization coefficient (that is, the number of ion pairs created per cm. per electron) of which is high, and is also increased to a lesser extent by using lighter gases.

For example, in a tube with electrode spacing about 15 mm., connected across a condenser of capacity 2 microfarads charged initially to 300 volts, the current rises from about 1 amp. to 10 amp. in about 12 × 10^{-8} sec. with the tube filled with air at 2 mm. mercury pressure. It rises by this amount in 6 × 10^{-8} sec. if filled with argon at 2 mm. pressure, and takes about 4 × 10^{-8} sec. if filled with helium at 2 mm. pressure.

It is hoped to publish a fuller account of this work in due course elsewhere.

I am indebted to Sir George Thomson for valuable discussion and advice; and to Dr. M. Blackman for discussions on cathode heating.

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Dec. 4.

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[1] For references, see Henry, *J. Sci. Instr.*, 32, 135 (1944).

Heat of Atomization of Carbon

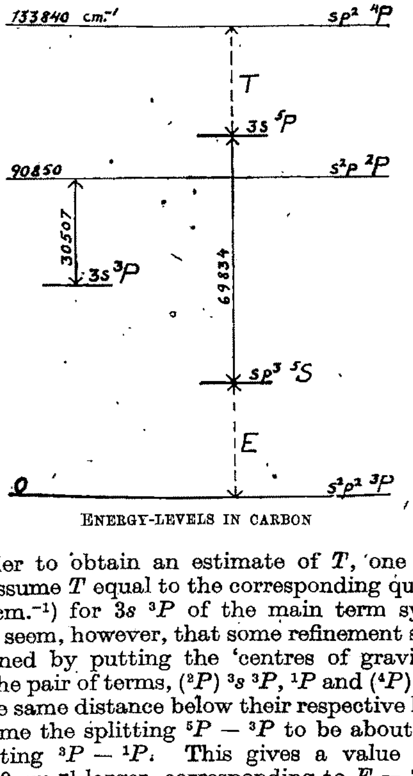
IN a private letter from Princeton dated April 26, 1939, Prof. A. G. Shenstone reported the following observation: "In all cases where I have photographed arcs in N_2 using carbon electrodes I have observed three lines which act like C I lines although I have found no trace of them in the literature. They are in the correct position and have proper intervals to be $sp^3\ {}^5S - sp^2s\ {}^5P$. They are quite sharp and I think my measures are probably good to ± 0·01 A.:

λ		ν		
1431·595	20	69852·1		$sp^3\ {}^5S_2 - sp^2 3s\ {}^5P_3$
			25·3	
1432·115	15	69826·8		$-\ {}^5P_2$
			20·6	
1432·538	10	69806·2		$-\ {}^5P_1$"

The suggested identification of Shenstone's lines is strongly supported by the iso-electronic comparison, as shown in the accompanying table, and is no doubt

	$sp^3\ {}^5S_2 - sp^2 3s\ {}^5P_3$		$sp^2 3s\ {}^5P_3 - {}^5P_1$		
	$(\nu - RN^2\ 5/36) \times 10^{-3}$ cm.$^{-1}$		$\Delta\nu$ cm.$^{-1}$	$\sqrt[4]{\Delta\nu}$	
C I	54·61		45·9	2:603	
		43·36			0·751
N II	97·97		126·6	3·354	
		43·40			0·757
O III	141·37		285·6	4·111	
		43·55			0·752
F IV	184·92		559·4	4·863	

correct. The discovery and identification of these carbon lines has reduced—as illustrated by the diagram—the problem of finding the excitation energy (E) of the important ${}^5S$-level to the simpler problem of deriving a value (T) of $3s\ {}^5P$ with respect to its parent term, the low ${}^4P$ of C II. The position of ${}^4P$ is fixed through inter-system combinations[1]. From the diagram, in which the figures correspond to the centre of gravity of each multiplet term, one finds $E = 64006 - T$ cm.$^{-1}$.



ENERGY-LEVELS IN CARBON

In order to obtain an estimate of T, one might simply assume T equal to the corresponding quantity (30,507 cm.$^{-1}$) for $3s\ {}^3P$ of the main term system. It would seem, however, that some refinement should be obtained by putting the 'centres of gravity' of each of the pair of terms, $({}^2P)\ 3s\ {}^3P, {}^1P$ and $({}^4P)\ 3s\ {}^5P, {}^3P$, at the same distance below their respective limits, and assume the splitting ${}^5P - {}^3P$ to be about twice the splitting ${}^3P - {}^1P$. This gives a value for T about 800 cm.$^{-1}$ larger, corresponding to $E = 32{,}700$ cm.$^{-1}$, or $E = 93\cdot4$ kcal./mole (using the conversion factor 1 cm.$^{-1}$ = 2·8575 cal./mole). With regard to known structures of similar spectra, the estimate of T should be reliable enough to justify the statement $E = 94 \pm 2$ kcal. In any event, the value around 70 kcal., which has been advocated on the basis of certain thermochemical considerations in the recent discussion[2] on the bond energies of carbon, would be unacceptable.

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[1] Edlén, B., *Z. Phys.*, **98**, 561 (1936).

[2] Long, L. H., and Norrish, R. G. W., *Nature*, **157**, 486 (1946). Valatin, J. G.; Long, L. H., and Norrish, R. G. W., *Nature*, **158**, 237 (1946).

IT is known that spectroscopic data are in agreement only with a series of discrete values for the dissociation energy of carbon monoxide (D_{CO}) and therefore also for the heat of sublimation of carbon (L_{C}).

The values of 11·11, 9·14 and 6·92 eV. for D_{CO} and 169·8, 124·4 and 73·2 kcal. for L_{C} have been considered by different authors. However, for each of these values several contradictory spectroscopic arguments can be presented[1].

Among methods used in attacking this problem, we wish to mention the determination of the vapour pressure of carbon. In 1936, Goldfinger and Jeunehomme[2] were able to show by thermodynamic calculations that the vapour-pressure curves for the three possible values of L_{C} lie far apart, and that, therefore, even rough measurements should suppress the ambiguity. A critical study of the known data, based on the idea that the measured pressure could lie below, but not above the equilibrium value, led to $L_{\text{C}} = 124$ kcal. as the most probable value[3]. This value was also admitted by Goldfinger, Lasareff and Rosen[4], as well as by Herzberg[1], and recently by Mulliken and Rieke[5]. The direct measurement of the triple point of carbon by Basset[6] is in excellent agreement with this value. Nevertheless, several workers do not agree with the interpretation of the experimental results.

Because of the persistent confusion in this important question, it seems necessary to use another method, which is based on the valency state of carbon in its tetrahedric compounds. It is well known that the state of the carbon atom in CH_4 cannot be represented either by ${}^3P$ or by ${}^5S$. Van Vleck has shown[7], by a thorough analysis, that the valency state of carbon in methane does not correspond to one of the sp^3 structures of the free atom but is a linear combination of them. He calculates a promotional energy of 7·1 eV. above the normal ${}^3P$ level; this state is, therefore, very different from the ${}^5S$ level, which according to Edlén lies at 4·2 eV. The identification of the actual state of the combined carbon atom with the ${}^5S$ level of the free atom or the neglect of the energy of re-organisation explains the confusion in a number of thermochemical discussions. The interesting points of view brought recently into the discussion[8] show certain apparent contradictions, which disappear by the use of the following method. Let us consider the well-known cycle:

$$\begin{array}{llcl}
CH_4 & = C_{\text{gas}} + 4H & - & W \\
4H & = 2H_2 & + & 2 \times 102\cdot4 \\
C_{\text{gas}} + O & = CO & + & D_{\text{CO}} \\
2H_2 + O_2 & = 2H_2O_{\text{liq.}} & + & 2 \times 68\cdot3 \\
C_{\text{sol}} + O_2 & = CO_2 & + & 94\cdot5 \\
2H_2O_{\text{liq.}} + CO_2 & = CH_4 + 2O_2 & - & 212\cdot8 \\
CO & = C_{\text{sol}} + 1/2\ O_2 & - & 27\cdot6 \\
1/2\ O_2 & = O & - & 1/2 \times 117\cdot5
\end{array}$$

which gives

$$W = D_{\text{CO}} + 136\cdot8 \text{ kcal.} \quad . \quad . \quad (1)$$

Penney has proposed[9], on the basis of Van Vleck's paper, a formula for the formation energy of methane from normal atoms:

$$W = 4\,E_{\text{CH}} - V(v) - 6\,M(H_2), \qquad (2)$$

where $V(v)$ is the activation or promotional energy of the carbon atom in CH_4, and $6\,M(H_2)$ the pairs of steric repulsions between the four hydrogen atoms.

Similarly, the formation energy of the methyl radical is given by:

$$W' = 3\,E_{CH} - [V(v) - w] - 3\,M(H_2), \quad (3)$$

where w is the difference of the promotional energies between CH_4 and CH_3.

The energy D of removal of the first hydrogen atom in methane according to

$$CH_4 = CH_3 + H - D\,. \quad . \quad . \quad (4)$$

is now well known from several experimental studies[10] and is equal to 100·8 kcal. According to (2), (3) and (4), D is not equal to E_{CH}, but is given by

$$D = W - W' = E_{CH} - w - 3\,M\,(H_2). \quad (5)$$

By taking E_{CH} from (2) and W from (1) and introducing them into (5) we obtain

$$D_{CO} = 4\,D - 136{\cdot}8 - [V(v) - 4w - 6\,M(H_2)].$$

According to Van Vleck[7] and Penney[9], the values for $V(v)$, $6\,M(H_2)$ and w are respectively 163, 51 and 15·6 kcal., and we obtain thus:

$$D_{CO} = 217 \text{ kcal., or } 9{\cdot}4 \text{ eV.; and } L_C = 132 \text{ kcal.}$$

Considering the uncertainty of about 10 per cent, generally admitted for the determination of $V(v)$, $M(H_2)$ and w, the agreement with the spectroscopic value of 9·11 eV. is very satisfactory, and must be considered as an important argument for $L_C = 124{\cdot}4$ kcal.

We wish to emphasize that the above values of D_{CO} and L_C are independent of spectroscopic data on the CO molecule. They would not be changed by a different interpretation of these data, resulting, for example, from the existence of maxima in the potential energy curves of this molecule.

The concept of promotional energy applies as well to other carbon compounds, especially to aldehydes, ketones and acids, as may be easily understood from the work of Goldfinger, Lasareff and Letort[11]. The method sketched above yields for these compounds promotional energies of about 150 kcal., as compared with Van Vleck's theoretical figure of 163 in methane. We hope to go into details of this question by experimental studies on several free radicals, especially CH_2 and CH_3CO.

It is to be noted that Kynch and Penney[12] have given arguments for $L_C = 170$ kcal. by comparing calculated and observed energies of excited states of molecules with conjugated double bonds. It seems, however, that their conclusions are not definitive, since they neglected to consider the removal of degeneracy of the excited states of butadiene and hexatriene. Further calculations might change their results noticeably, as has already been remarked by Mulliken and Rieke[5].

We may conclude that among all the discussed values, the value $L_C = 124{\cdot}4$ kcal. can alone be accepted, being in agreement with (a) spectroscopic data on the CO molecule; (b) vapour-pressure data on carbon; (c) removal energy of hydrogen from hydrocarbons and promotional energy of C in organic compounds.

On the other hand, by using the relation between the twisting frequency of the ethylene molecule and L_C, one of us has shown[13] that the value 170 kcal. is very improbable.

Finally, it is also very difficult to explain with this latter value the results of Faltings, Groth and Harteck[14] on the photochemical decomposition of CO, as well as the results of the studies on ionization of CO by electron impact[15].

Note added in proof. Voge[16] has obtained a value of the energy of the valency state of carbon which is appreciably lower than Van Vleck's estimate. In connexion with our considerations Voge's value (4·5 eV.) would lead to $D_{CO} \cong 12$ eV., a figure considerably higher than even the highest possible spectroscopic value. On the other hand, the relative removal energies of the four hydrogen atoms from methane seem incompatible with Voge's result.

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[1] Gaydon, A. G., and Penney, W. G., *Proc. Roy. Soc.*, A, **183**, 374 (1945). Herzberg, G., *Chem. Rev.*, **20**, 145 (1937). Schmid, R., and Gerö, L., *Z. Phys.*, **105**, 36 (1937). These papers discuss the arguments in favour of each of the values quoted as well as those against the intermediate possible values of 8·4 and 9·6 eV.

[2] Goldfinger, P., and Jeunehomme, W., *Trans. Farad. Soc.*, **32**, 1591 (1936).

[3] Ribaud, G., and Bégue, J., *C.R. Acad. Sci. Paris*, **221**, 73 (1945). Their values for the vapour pressure of carbon are too high for $L_C = 170$ but too low for $L_C = 124$ kcal.

[4] Goldfinger, P., Lasareff, W., and Rosen, B., *C.R. Acad. Sci. Paris*, **201**, 958 (1935).

[5] Mulliken, R. S., and Rieke, C. A., *Rev. Mod. Phys.*, **14**, 259 (1942).

[6] Basset, J., *C.R. Acad. Sci. Paris*, **208**, 267 (1939); *J. Phys. Rad.*, **10**, 217 (1939).

[7] Van Vleck, J. H., *J. Chem. Phys.*, **2**, 20, 297 (1934).

[8] Long, L. H., and Norrish, R. G. W., *Nature*, **157**, 486 (1946): **158**, 237 (1946). Sidgwick, N. V., and Springall, H. D., *Nature*, **156**, 600 (1945). Baughan, E. G., *Nature*, **147**, 542 (1941). Baughan, E. G., and Polanyi, M., *Nature*, **146**, 685 (1940).

[9] Penney, W. G., *Trans. Farad. Soc.*, **31**, 734 (1935).

[10] Andersen, H. C., and Kistiakowsky, G. B., *J. Chem. Phys.*, **11**, 6 (1943). Kistiakowsky, G. B., and Van Artsdalen, E. R., *J. Chem. Phys.*, **12**, 479 (1944).

[11] Goldfinger, P., Lasareff, W., and Letort, M., *C.R. Acad. Sci. Paris*, **200**, 1593 (1935).

[12] Kynch, G. J., and Penney, W. G., *Proc. Roy. Soc.*, A, **179**, 214 (1941).

[13] Duchesne, J., *Physica*, **10**, 817 (1943).

[14] Faltings, K., Groth, W., and Harteck, P., *Z. Phys. Chem.*, B, **41**, 15 (1938).

[15] Hagstrum, H. D., and Tate, J. T., *Phys. Rev.*, **59**, 354 (1941).

[16] Voge, *J. Chem. Phys.*, **4**, 581 (1936).

In view of the fact that the evidence obtained by Prof. Shenstone in 1939 has not yet been published, and that others have not had an opportunity of considering the conditions under which his spectra were obtained, or of examining the spectra as a whole, we feel that the statement made by Prof. Edlén at the end of his letter cannot be accepted as final. In any event, it would appear to us that his argument by analogy requires further confirmation.

The communication of Messrs. Duchesne, Goldfinger and Rosen provides valuable confirmation for the value $L_1 = 125$ kcal. which on other grounds we have advocated[1] as the most probable value for the reaction

$$C_{\text{solid}} \longrightarrow C_{\text{gas}}\,(^3P).$$

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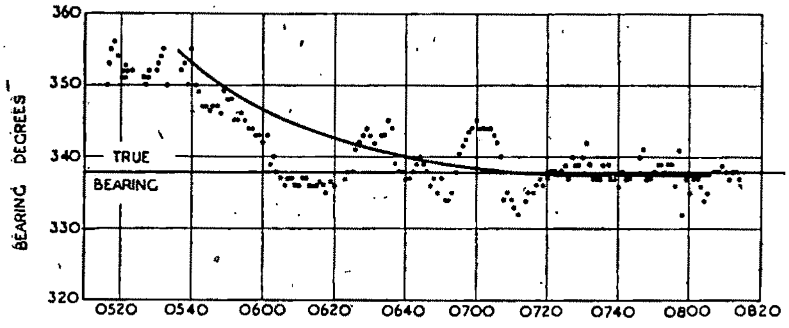
[1] Long and Norrish, *Nature*, **157**, 486 (1946); *Proc. Roy. Soc.*, **187**, 337 (1946).

Lateral Deviation of Radio Waves at Sunrise

THE observation of systematic lateral deviations of radio waves requires that such deviations shall be large enough not to be obscured by the random deviations always occurring. The sunrise period is particularly favourable for such observations, since the relatively rapid changes in ionization at this time produce appreciable horizontal ionization gradients. The direction of these is such as to move the reflexion point of the ray towards the east, and qualitative confirmation of this effect has previously been noted.

Some further observations have been made at the Radio Research Station, Slough, on the British Broadcasting Corporation 6·05 Mc./s. transmitter *GSA* in Cumberland, a distance of about 400 km. from Slough. The experiments were carried out during April and May 1946, the sunrise line being then approximately along the transmission path. The instrument used was a rotating spaced-loop direction finder[1], and the period of observation was two to three hours around sunrise, covering the normal time at which the maximum usable frequency condition was attained.



BEARING OF *GSA* AT SLOUGH, APRIL 12, 1946
······, observed bearing; ——, calculated bearing

The bearings immediately following the maximum usable frequency condition were usually some ten or twenty degrees to the east of the true direction, which was afterwards gradually approached. This process occupied a time varying on different days from a few minutes up to nearly an hour. Thereafter the bearings showed fluctuations of a few degrees about the true value but no systematic deviations.

A quantitative estimate may be made of bearing deviations to be expected from the changes with time of equivalent height of reflexion, obtained from vertical incidence ionospheric data. Calculations on this basis agree with the directional observations in giving the largest deviations when the frequency is close to the maximum usable frequency, since the equivalent height is then falling most rapidly with advancing time.

Detailed quantitative correlation is not in general possible owing to complications involved by the presence of the extraordinary ray. On one occasion, however, when the observed bearing changes took place comparatively slowly, a simple calculation of equivalent height based on the ordinary-ray transmission alone was found to give good agreement with the experimental results. The observed and computed bearings are shown in the accompanying graph.

The ionospheric data used were obtained from vertical incidence measurements made at the Radio Research Station, Slough, and this note is publish by permission of the Department of Scientific a Industrial Research.

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Teddington.
Nov. 1.

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[1] Ross, W., *J. Inst. Elect. Eng.*, in the press.

Fluid Flow at a Small Hole due to Vibrati

PROF. GILBERT WEST has recently described[1] ingenious experiment in which a stream of smo laden air is made to issue from a hole in a cylindri resonator when an appropriate tuning fork is broug near. This is said to demonstrate the pressure sound, but I am much in doubt as to whether does so.

The passage of a sound wave cannot cause a bulk streaming of the air, so that the suggestion I take it, that the sound wave exerts a pressure each smoke particle, as it undoubtedly does on extended surface. I have point out, however, that an ordina smoke particle takes up practica the full vibratory amplitude of t air at ordinary frequencies; example, at 600 c./sec. smo particles of diameter $1\,\mu$ acqu 0·9999 of the full amplitude the sound vibration[2]. In the circumstances no pressure is erted on them.

Prof. West's experiment is, in opinion, a demonstration of an teresting effect known to me many years and first described, believe, by H. Sell[3]. A cylindri box is closed on one side by flat surface carrying a small metal jet: opposite t is a diaphragm which can be set in vibration. Wh the diaphragm is excited there issues from the je stream of air which can blow a light vane asi The explanation is quite simple. When the diaphrag moves so as to expel the air, the air issues in a we defined stream; when it moves back so as to su in the air, the air enters from all sides. The expelled is equal in volume to that sucked in, b the path of the entering air differs from that of t expelled air, just as the lines of flow of a liquid at t entry of a capillary tube differ from the lines of fl at exit.

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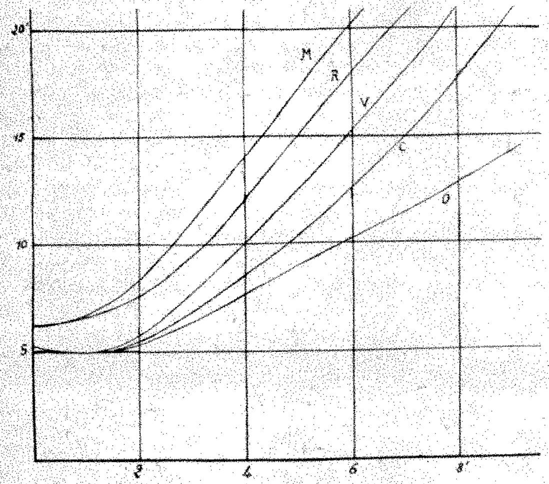
[1] *Nature*, 158, 755 (1946).
[2] *Proc. Roy. Soc.*, A, 134, 445 (1931).
[3] *Z. tech. Phys.*, 5, 573 (1924).

Measurement of Visual Acuity with Blurred Tests

WHEN testing visual acuity with Snellen's curre type, we use black letters printed upon a whi ground, and the transition from black to white is abrupt as can be. If the patient's eyes are emmetrop or hyperopic without presbyopia, or myopic and co rected, the retinal image of the test remains shar and visual acuity is limited only by the structure of the retina and the aberrations of the eye. On the contrary, when the patient's eyes are myopic and not corrected, the retinal images are blurred and visual acuity is poor. This relation of visual acuity to ametropia has been studied by W. Swaine[1], whose measurements one of us has shown to be in fair agreement with theory[2]. But further experiments were necessary.

When an ametropic eye is looking at a sharp test object, it is difficult to measure the blurring of its retinal imagery; but, for the same purpose, we may use an emmetropic eye looking at a blurred test object. Such test objects can be made very easily by the projection of a transparent slide (with opaque letters) upon a diffusing screen which is systematically put out of focus. By this means, we found that various letters resisted this blurring to various degrees, as can be seen from the graph, which shows the characteristic curves of five letters; the scale of abscissæ gives the apparent diameter, in minutes of arc, of the diffusion circle corresponding to an object point; the scale of ordinates gives, in minutes of arc also, the minimum angle subtended by the heights of the letters when the latter are just recognized; in fact, these heights are those of sharp letters as they would appear on the screen if the aperture of the projection lens were very small. The apparent heights are actually larger, because of the diffusion band, and this fact explains the paradoxical amelioration of acuity which we sometimes observed when images began to be blurred.



Complete results will be published elsewhere, and we hope they will allow a rational classification of Snellen's letters, based upon their resistance to blurring. We hope also to make experiments with an asymmetric blurring, similar to the effect of astigmatism upon vision.

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Nov. 25.

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[1] Swaine, W., *Trans. Opt. Soc.*, **27**, 9 (1925–26).

[2] Le Grand, Y., "Optique Physiologique", 251 (Ed. de la Revue d'Optique, Paris, 1946).

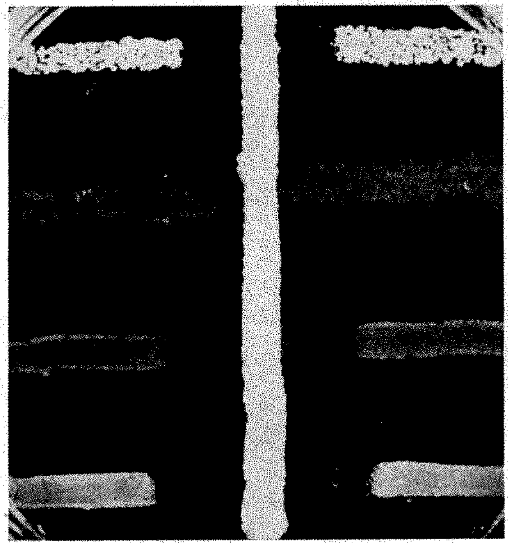
Antibacterial Activity of the Staphylococcus

The observation that the Staphylococcus can inhibit the growth of other bacteria has been recorded in some fifty papers over a period of sixty years, beginning with Babès[1], who showed that a Staphylococcus inhibited the growth of *B. anthracis* and of another staphylococcus. The majority of reports have been concerned with the action of Staphylococci against the diphtheria bacillus. In 1909, Schiøtz[2] recorded the observations that a patient with a staphylococcal sore throat, nursed in a diphtheria ward because of a mistaken diagnosis, did not develop diphtheria, and that carriers became free of the diphtheria bacillus during a non-specific throat infection. There followed a number of attempts, mostly in the United States, to use Staphylococci in a spray to treat diphtheria carriers.

More recently, inhibitory Staphylococci have been examined by a number of workers, of whom Dujardin-Beaumetz[3] was among the first to produce convincing evidence that the inhibition was due to the production of an antibacterial substance.

Experimental. As a preliminary to further work, two hundred and five strains of Staphylococcus have been surveyed for their inhibitory power on a solid medium. The strains were obtained through the kindness of Dr. R. L. Vollum, of the Emergency Public Health Laboratory Service. All but six came from human sources. The majority were picked at random off routine diagnostic plates, mostly from nose or throat swabs, some had been isolated from septic wounds at the Birmingham Accident Hospital, and three had been specially selected, being derived from cultures from patients with diphtheria in which difficulty in isolating the diphtheria bacillus had been attributed to the action of an accompanying Staphylococcus.

Agar plates containing 5 per cent serum were inoculated by streaking a loopful of broth culture of the Staphylococcus across the diameter. After the plates had been incubated over-night, selected test organisms were streaked at right-angles on both sides of the primary streak, the size of the inoculum being regulated to give a growth which was just confluent



Inhibition by active Staphylococcus on agar plate. Organisms cross-streaked are, from top to bottom, *Staph. aureus*, *Bact. coli*, *C. diphtheriæ* var. *gravis*, *C. xerosis* but not heavy. The test organisms used were *Staph. aureus* 'H', N.C.T.C. No. 6571, and laboratory stock strains of *Corynebacterium xerosis*, *C. diphtheriæ* and *Bact. coli*. After re-incubation, inhibition if present was recorded as the distance in millimetres between the edge of the primary streak and the beginning of growth in the secondary streak. Inhibition was invariably symmetrical on the two halves of the plate. The accompanying reproduction shows a representative plate, streaked with an active strain. All the active and eighty-five of the inactive strains chosen at random were tested for coagulose production, and all the active strains for pigment production and fermentation of lactose and mannitol.

TABLE 1. SOURCE AND ANTIBACTERIAL ACTIVITY OF STRAINS OF STAPHYLOCOCCUS

Selection	Source	No. of strains		
		Active	Inactive	Total
Random	nose or throat	20	116	136
	wound	3	51	54
	miscellaneous	0	12	12
	Total	23	179	202
For suspected inhibitory power	throat diphtheria	3	0	3
	Total	26	179	205

Results. Table 1 summarizes the origin and activity of the strains examined. Of the organisms tested, *C. xerosis* was inhibited by all the twenty-six active strains, *Staph. aureus* and *C. diphtheriæ* by most of them, and *Bact. coli* by none. The strains differed in the amount of inhibition which they produced. When arranged in order of activity the gradation from strong to weak inhibition of *C. xerosis*, the most sensitive test organism, was paralleled with *Staph. aureus* and *C. diphtheriæ*. Whether or not each of these organisms was inhibited appeared to be a quantitative rather than a qualitative matter. In additional tests it was shown that the *gravis*, *intermedius* and *mitis* varieties of *C. diphtheriæ* were inhibited about equally, that *C. hofmannii* was inhibited equally with *C. xerosis*, and that *Ps. pyocyanea* and *Salm. enteritidis* (Gaertner) were, like *Bact. coli*, not inhibited at all.

Within the limits of the numbers investigated none of the metabolic characters examined was related to the amount of inhibition produced. The six active *albus* strains, for example, were scattered evenly through the series. It was further shown, in respect of one metabolic character, namely, coagulase production, that the proportion of strains possessing it was the same among the active Staphylococci and among eighty-five of the inactive strains chosen at random. The figures are given in Table 2.

TABLE 2. PRODUCTION OF COAGULASE BY STAPHYLOCOCCI ACTIVE AND INACTIVE AGAINST BACTERIA

Antibacterial activity	No. of strains		Per cent positive
	total examined	coagulase positive	
Present	26	19	73
Absent	85	56	66

Some strains of Pneumococcus and Streptococcus form hydrogen peroxide in sufficient quantity to produce wide zones of inhibition on a streak plate, but this has never been reported for the Staphylococcus. That it did not account for any of the inhibitory activity of these strains was established first by the differential nature of the inhibition, since peroxide inhibits all the test bacteria about equally, and secondly by reproducing the activity of all strains on a medium containing catalase.

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Dec. 19.

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[1] Babès, V., *J. Conn. Méd. Prat. Paris*, **7**, 321 (1885).

[2] Schiøtz, A., *Ugeskrift f. Læger, Copenhagen*, **71**, 1373 (1909).

[3] Dujardin-Beaumetz, E., *C.R. Soc. Biol., Paris*, **110**, 1210 (1932).

Rhythmical Impedance Changes in Salmon Eggs

THE protoplasmic membranes of fertilized and unfertilized trout eggs undergo periodic structural changes after being in tap-water for about seven hours. These changes are associated with variations in electrical impedance[1]. The frequency of the impedance change is approximately 1/1·5 min., and the effect can be abolished reversibly by phenyl urethane[2]. Through the kindness of Prof. J. H. Orton, of the University of Liverpool, and Mr. G. M. King, of the Dee Fishery Board, fertilized and unfertilized salmon eggs have been examined in the same way as trout eggs, in an alternating current-bridge of high sensitivity, with a visual detector. Salmon eggs undergo periodic impedance changes (Fig. 1), which are remarkably similar to those previously observed in trout eggs. Their frequency at 16·5° C. is approximately 1/3 min.

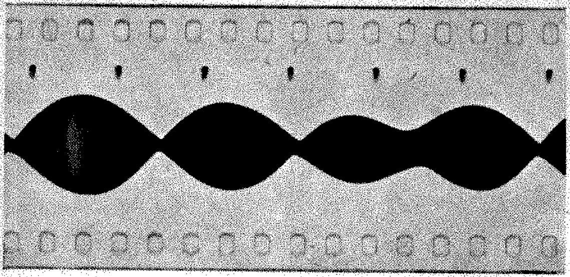

Fig. 1. PERIODIC IMPEDANCE CHANGE IN FERTILIZED SALMON EGG, TWO DAYS AFTER FERTILIZATION. TIME-MARKER, MINUTES

As in the trout egg, the impedance cycle can be resolved into two components: a 'fundamental' change, and another with one half the frequency, which has the effect of making every fourth bridge balance less sharp than the previous three. In some eggs, particularly those which are more than two days old, this effect is very marked.

The trout egg impedance cycle has been analysed in terms of the vitelline membrane resistance and capacitance, and it is found, somewhat surprisingly, to be mainly capacitative[3], though small changes in resistance may be difficult to observe if the membrane resistance is very high. The same applies in the salmon egg. A salmon egg circle diagram (time-admittance locus, similar to the 'time-impedance locus' described by Cole and Curtis[4]) is shown in Fig. 2.

It will be seen that the $1/R_p$, ωC_p co-ordinates at different times but at the same frequency lie on an arc of a circle, indicating that the impedance change seems to be mainly due to a change in membrane capacitance. There is only a very slight suggestion

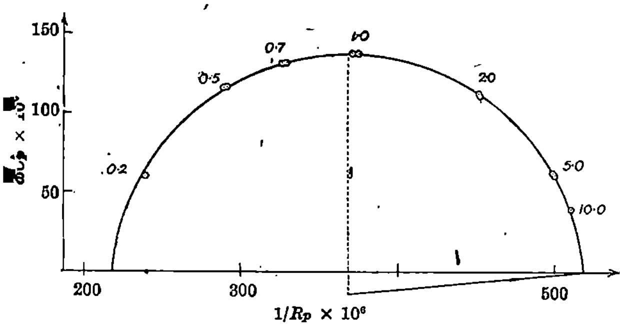

Fig. 2. TIME ADMITTANCE LOCUS OF SAME EGG AS IN FIG. 1, SHOWING THE CO-ORDINATES $1/R_p$, ωC_p, OSCILLATING ALONG AN ARC OF A CIRCLE. FREQUENCIES IN KILOCYCLES

that membrane resistance is involved. The membrane phase angle is 84°, and the membrane impedance is of the form $|z| = K\omega^{-2\varphi/\pi}$. There is no change of phase-angle during the impedance cycle.

The meaning of these impedance cycles will only become clearer when eggs, or other cells which exhibit this phenomenon, are put through their physiological or biochemical paces. So far, these eggs are the only living material in which such changes have been observed; they may be peculiar to this type of egg, which is morphologically somewhat specialized. On the other hand, these eggs are specially suitable for very sensitive measurements of bio-electrical properties, as they present the experimenter with a thin spherical shell of protoplasm the area of which is nearly 1 sq. cm. Other material might not be so favourable for the observation of these rhythmical changes in protoplasmic structure.

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[1] Hubbard, M. J., and Rothschild, Lord, *Proc. Roy. Soc.*, B, **127**, 510 (1939).

[2] Rothschild, Lord, *Nature*, **145**, 744 (1940).

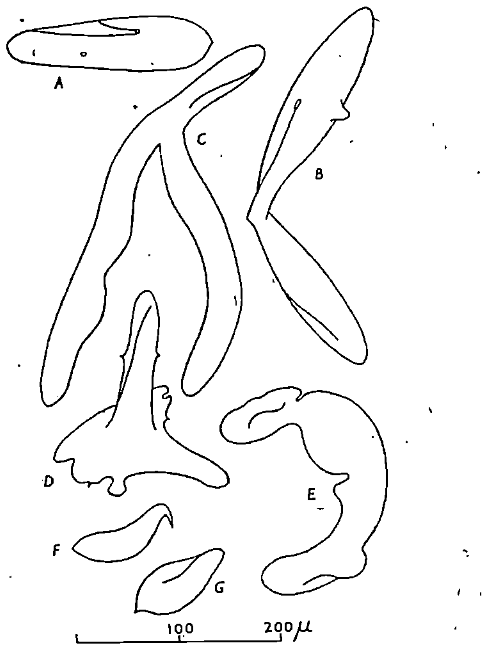
[3] Rothschild, Lord, *J. Exp. Biol.*, in the press.

[4] Cole, K. S., and Curtis, H. J., *J. Gen. Physiol.*, **22**, 37 (1938).

Unco-ordinated Growth in *Paramecium* Induced by 'Gammexane'

THE γ-isomer of hexachlorocyclohexane ('Gammexane') is toxic to *Paramecium caudatum* when introduced into the cultures at a rate of 10 parts per million down to 1 per million. The action of the poison is slow and cumulative, the organisms continuing to feed until near death. Nuclear division is inhibited, and so they become hypertrophied, increasing in length and breadth up to 50 per cent beyond normal. There is a threshold concentration of the drug somewhere between 1 and 0·5 parts per million where some normal division occurs, but a proportion of the hypertrophied cells divide as to the nuclei but not as to the body of the cell itself. Consequently, Siamese-twin forms are produced which feed and live a long time without making further progress, except that a small lateral outgrowth sometimes suggests that they might produce buds. Complete budding has not been observed in the 'Gammexane'-treated medium.

When the twin forms, or highly hypertrophied *Paramecium* from the lower 'Gammexane' concentrations, are placed in normal medium, macronuclei and micronuclei divide repeatedly while the cell throws out lobes in all directions. As many as fourteen micronuclei have been counted in one individual while the macronucleus was throwing off pieces of varying size. Buds become detached with varying nuclear combinations, and while it is likely that all these buds are not viable, some of them succeed in starting fresh colonies of apparently normal individuals. These budding forms have several times the bulk of a normal *Paramecium*, are ciliated all over in the normal way, and have a pharynx or sometimes two pharyngeal openings. They feed, and the cilia are active; small ones swim, but the large ones contort themselves and roll over constantly but are too heavy to move from the floor. The accompanying illustration shows the normal form of *Paramecium* and some of the smaller abnormal forms drawn from life. It should be noted that while the pressure of the drug is on them, only simple Siamese twins are formed; but when this pressure is relieved the fully unco-ordinated growth occurs. In a manuscript on this topic by the late J. C. Mottram, who has recorded these abnormal growths in *Paramecium* after contact with several of the cyclic hydrocarbons[1], emphasis is also laid on the two factors, one sensitizing and the other developing.



NORMAL *Paramecium* AND FORMS DISTORTED BY 'GAMMEXANE'. (*a*) NORMAL; (*b*) THE SIAMESE TWINS; (*c*), (*d*), (*e*) SMALL BUDDING FORMS; (*f*), (*g*) FREED BUDS. ALL ARE FULLY CILIATED. DRAWN FROM LIFE

This development arises out of my connexion with the informal committee on sewage filter-flies of the Water Pollution Research Board (Department of Scientific and Industrial Research). My thanks are due to the officers of the Board for the supply of materials. A full account of the method of obtaining these abnormalities and of the behaviour so far observed will shortly be ready for publication.

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Nov. 30.

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[1] Mottram, J. C., "The Problem of Tumours" (London, 1942).

Polyploidy in *Polypodium vulgare*

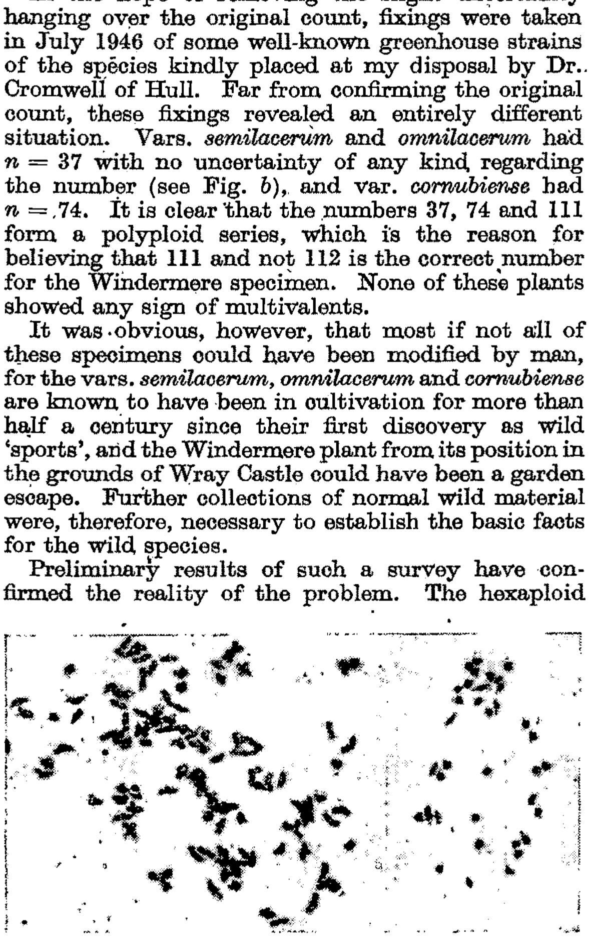
THE common polypody (*Polypodium vulgare* L.) is such an apparently well-defined and isolated species, being the only one of its kind hitherto recognized in Europe, that it was a matter of considerable surprise to detect in it cytological complexities recalling those of the Male fern[1] without, fortunately, quite equalling the full intricacies of that 'species'. *Polypodium* is, however, complicated enough to need a very large collection of living samples from all over its geographical range before it will be adequately understood, and it is in the hope of soliciting the cooperation of correspondents both in Great Britain and farther afield that this note has been offered for publication.

Polypodium sporangia mature late in the season (August or September in northern England). The first chromosome count made with any pretension to accuracy was obtained in September 1944 from a normal-looking and apparently wild plant in the grounds of the Biological Station at Wray Castle (Windermere). One cell is shown in Fig. *a*, and the chromosome number, known to be accurate to within three chromosomes, was at first recorded as $n =$ 'approx. 112'; there is now (see below) strong reason for believing that the correct number for this plant is $n = 111$.

In the hope of removing the slight uncertainty hanging over the original count, fixings were taken in July 1946 of some well-known greenhouse strains of the species kindly placed at my disposal by Dr. Cromwell of Hull. Far from confirming the original count, these fixings revealed an entirely different situation. Vars. *semilacerum* and *omnilacerum* had $n = 37$ with no uncertainty of any kind regarding the number (see Fig. *b*), and var. *cornubiense* had $n = 74$. It is clear that the numbers 37, 74 and 111 form a polyploid series, which is the reason for believing that 111 and not 112 is the correct number for the Windermere specimen. None of these plants showed any sign of multivalents.

It was obvious, however, that most if not all of these specimens could have been modified by man, for the vars. *semilacerum*, *omnilacerum* and *cornubiense* are known to have been in cultivation for more than half a century since their first discovery as wild 'sports', and the Windermere plant from its position in the grounds of Wray Castle could have been a garden escape. Further collections of normal wild material were, therefore, necessary to establish the basic facts for the wild species.

Preliminary results of such a survey have confirmed the reality of the problem. The hexaploid (as the Windermere plant may be called) has not so far been found again, but specimens from a wood near Kendal (Westmorland) and from a very remote spot on Rannoch Moor (Perthshire) were tetraploid (that is, $n = 74$). Diploids ($n = 37$) were found at Dartmouth (Devon), the Cheddar Gorge (Somerset), and in a plant brought back from the neighbourhood of Montpellier (Pont du Gard) in southern France in 1946. The Montpellier plant belongs to *P. vulgare* var. *serratum*, which is the only representative of *Polypodium* in that part of Europe, and it is probable that the British diploids will also be referable to var. *serratum*, though their characters are less clearly defined than in the French material.



MEIOTIC METAPHASES IN ACETOCARMINE OF A HEXAPLOID AND A DIPLOID *Polypodium*. × 500. (*a*) MORPHOLOGICALLY NORMAL SPECIMEN FROM WINDERMERE; (*b*) THE HORTICULTURAL VARIETY 'SEMILACERUM'

While it seems highly probable that 'var. *serratum*' will need to be recognized as a second European species of *Polypodium*, it is clearly desirable, before this is done, for information on a much larger scale to be assembled. All forms of *Polypodium* are easily recognizable as such even by amateurs, and they are remarkably tolerant of rough handling. If firmly wrapped to prevent desiccation, they will probably survive a postal period of several weeks.

I would be very grateful for any living specimens that can be sent to me from Great Britain, Europe or America, provided that the place of origin is clearly indicated. To facilitate transmission from abroad, non-British parcels may be addressed to the Keeper of the Herbarium, Royal Botanic Gardens, Kew, Surrey.

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Dec. 10.

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[1] Manton, I., *Nature*, 144, 291 (1939).

Effect of Temperature of Storage on the Rate of Loss of Fertility of Stock Cultures of *Melanospora destruens*

MYCOLOGICAL literature contains many references to loss of fertility by fungi in culture. During an investigation of the physiology of perithecial production in *Melanospora destruens* Shear, the strain became progressively less fertile. Fertile saltants developed in cultures grown at the relatively high temperature of 37° C. These were isolated and their growth-rates were compared with those of sterile saltants at various temperatures.

At relatively low temperatures, namely, laboratory temperature (18° C.) and 20° C., growth of the sterile strains began several hours before that of the fertile ones. At 25° C. the difference was reduced, while at 30° C. and above, the growth-rates of the sterile and fertile strains were approximately equal.

Thus it is clear that if stock cultures of this fungus are kept at laboratory temperature, the chances of picking up any sterile saltants present when subculturing would be greatly increased, since these are likely to become established before the fertile ones commence growth, and so would probably prevent the development of the latter. If, however, the stock cultures were incubated at 30° C. for at least two days after subculturing, the chances of survival of the fertile strains would be greatly increased. This problem is being investigated, and it is hoped to publish a fuller account later.

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MECHANISM OF HIGH ACID PRODUCTION BY YEAST AND ITS BEARING ON HYDROCHLORIC ACID FORMATION IN THE STOMACH

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AND

Dr. THOMAS BRADY

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As previously described[1], when baker's yeast ferments unbuffered glucose solutions, a high degree of acidity can be reached if potassium chloride in the suspending fluid is brought to about 0·1 *M*. With simple variations of the conditions, *p*H values as low as 1·49 have now been occasionally observed, and often a *p*H of 1·6.

The high acidity arises from an exchange of hydrogen and potassium ions[1]. In the search for the source of the hydrogen ions, we were at first influenced by the view that one acid would be largely if not entirely involved, and probably an acid with *p*K value as low as 2–3. From the inhibiting action of fluoride and iodoacetic acid, such an acid could be expected at or below the level of pyruvic acid. A parallelism was found between the rate of pyruvic acid production and the acidity, and very probably this acid (as well as phosphopyruvic acid) plays a part in potassium and hydrogen exchanges, but it accounts only for a small fraction, as appears from the quantitative relations. The truth seems to be that various acids formed in the breakdown of the sugar can take part, but the evidence shows that the major part of the exchange is due to succinic and carbonic acids, the latter free or protein-linked. It may be noted that when yeast carboxylase acts on pyruvic acid, carbonic acid (H_2CO_3) is directly formed and not carbon dioxide[2], and a fuller investigation of the question has now provided evidence that it can largely participate in the hydrogen ion exchange, though it is not clear so far if it does so directly or as some protein-linked compound.

Evidence for the participation of succinic acid. When yeast ferments glucose under the conditions described above, succinic acid appears in the fluid outside the cells, rapidly and in surprising quantity. At the same time the concentration of succinic acid in the cells is only a small fraction of that outside. If potassium chloride be present in the suspending fluid (to about 0·1 *M*) considerably less succinic acid appears in the free fluid, but an amount corresponding largely with this reduction is retained inside the yeast cells, the potassium chloride having at the same time little or no effect on the average rate of production of carbon dioxide.

The accompanying table gives the mean data for three experiments:

Nature of suspension (1 pt. of moist yeast to 0·6 pt. suspending fluid, mgm. per cent)	Succinic acid in the suspension (mgm. per cent)	Succinic acid in fluid after centrifuging (mgm. per cent)	Succinic acid in yeast cells (calculated value) (mgm. per cent)	*p*H of suspension
Without KCl	85	155	12	3·03
With KCl	78	111	44	1·97

The interspaces between the cells had a mean value of 22 c.c. per 100 gm. yeast as shown by studies of the inulin space.

The succinic acid retained in the cells in the presence of potassium chloride accounted for approximately 45 per cent of the hydrogen and potassium ion interchange, assuming one of the ionizing groups (*p*K of 4·2) to contribute the hydrogen ions. Further supporting evidence for the contribution of succinic acid in the hydrogen and potassium ion exchanges could also be furnished.

If another *organic* acid were associated with the exchange, it could be expected to appear like succinic in the suspending fluid; but analysis shows that upwards of 80–90 per cent of the organic acid in the suspending fluid is, in fact, succinic.

Evidence for the participation of carbonic acid in the potassium and hydrogen ion exchanges. When, in such experiments, whether conducted *in vacuo* or at atmospheric pressure, or again when through fermenting mixtures carbon dioxide is freely bubbled at atmospheric pressure, in the presence of potassium chloride there is found in nearly all cases an excess of acid-labile carbon dioxide (other than free carbon dioxide). This, on the average, is sufficient to account for a high proportion of the potassium and hydrogen ion exchange (about 40–50 per cent, but occasionally higher). The excess of acid-labile carbon dioxide increases up to 30–50 min. and then falls as the fermentation decreases.

Bearing of these experiments on hydrochloric acid production by the gastric mucosa. The apparent participation of carbonic acid (or of some immediate associate) in the high acid production by yeast is of special interest for hydrochloric acid formation by the gastric mucosa. The view has been previously advanced by Davenport and Fisher[3] that carbon dioxide is associated with this production, the change to carbonic acid being catalysed by carbonic anhydrase; but the view that this enzyme plays a direct part in the hydrochloric acid formation appears no longer tenable[4]. The literature up to recent years has been summarized by Hollander[5] and by Babkin[6].

Here it is considered that the entrance of carbonic acid is quite the opposite of that proposed by Davenport, for free carbonic acid and not carbon dioxide is formed by carboxylase on pyruvic acid (and in such decarboxylation it may be presumed to be always so formed). At the same time, it is probable that it is not the H_2CO_3–HCO_3' system that is the fully operative mechanism, but that protein-linked carbonic acid is associated, helping to damp down the rate of passage to carbon dioxide gas.

In recent studies on the respiratory exchange and hydrochloric acid production with the gastric mucosa of the frog[7], Davies and co-workers appear to have obtained results of much value. From their account it would seem that they have obtained occasionally Q_{HCl} values much higher than Q_{O_2} figures. At the same time, it may be noted that when Q_{HCl} exceeded twice Q_{O_2}, with the mucosal sack immersed in bicarbonate saline, the tissue appeared damaged, and in phosphate saline the damage seemed obvious with Q_{HCl} just above the Q_{O_2}.

The findings of Davies—so far indicated—in no way disprove the essentials of the theory proposed from their Department as to the manner of the hydrochloric acid formation. In this theory potassium chloride is first excreted as a neutral chloride, and then potassium ions are exchanged for hydrogen ions across a membrane, the latter ions being furnished in the metabolic processes of the cell. It is clear that the simplest source of such hydrogen ions could be the carbonic acid formed metabolically, but this may be supplemented by organic acid formation, and especially when the tissue is not in good condition, in which case Q_{HCl} may exceed Q_{O_2}. At the same time, it is possible that a cyclical formation of an acid such as phosphopyruvic could occur at the site of the hydrogen ion exchange, and then be reversed to a substance of weaker acidity within the cell. The actual concentration of the operating acid need only be small, but charging the membrane with a relatively high concentration of hydrogen ions. Such a cyclical process could give Q_{HCl} values far higher than Q_{O_2} values, the ratio being limited only by the available energy and the efficiency of its utilization—a limiting condition of any process involved in the formation of hydrochloric acid.

Concerning the action of carbonic anhydrase (which was shown by Davenport to be present in relatively large amounts in the gastric mucosa, and in the stomachs of cats, rats and dogs to be present almost exclusively in the parietal cells), any view which considers the anhydrase to hasten the change of carbon dioxide to carbonic acid at the site of its formation is very probably incorrect. This is so because of the analogy of the yeast carboxylase action[3], and the structure of the carboxylic acids; and all decarboxylations may be considered as involving a primary formation of carbonic acid. But when, as the result of the processes above considered, HCO_3' ion accumulates, the excretion of this ion into the blood may be accelerated by conversion to carbon dioxide (hastened by carbonic anhydrase) and by a chlorine ion and HCO_3' exchange.

[1] Conway, E. J., and O'Malley, E., *Biochem. J.*, **40**, 59 (1946).
[2] Conway, E. J., and MacDonnell, E., *Nature*, **156**, 752 (1945).
[3] Davenport, H. W., and Fisher, R. B., *J. Physiol.*, **94**, 16P (1938–39); *Amer. J. Physiol.*, **131**, 165 (1940).
[4] Feldberg, W., Keilin, D., and Mann, T., *Nature*, **146**, 651 (1940).
[5] Hollander, F., *Gastroenterology*, **1**, 401 (1943).
[6] Babkin, B. P., "Secretory Mechanism of the Digestive Glands" (1944).
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[8] Davies, R. E., and Longmuir, N. M., *Proc. Biochem. Soc.* (1946).

HIGH POLYMERS

STRASBOURG CONFERENCE

AN international conference on high polymers was held at the University of Strasbourg during the week of November 25. This is the first of a number of conferences on special subjects to be held in France, arranged by the Centre National de Recherche Scientifique, under the sponsorship of the Rockefeller Foundation. Each conference is designed for the intensive discussion of current research by a relatively small group of French and foreign men of science.

The papers presented at this conference were restricted to the subject of the molecular properties of large molecules, for it was felt that a discussion extending over the entire field was impractical. The programme was as follows: W. T. Astbury (Great Britain), X-ray research on the structure of chain-like molecules; M. L. Huggins (United States), statistical thermodynamics of polymer solutions; G. Gee (Great Britain), statistical thermodynamics of polymer solutions; Mme. A. Dobry (France), incompatibility and demixing of macromolecules; H. Benoit (France), statistics of polymer molecules; C. Sadron (France), the particle equivalent of a polymer molecule; M. Gibert (France), measurement of translational diffusion; M. Calvet (France), measurement of translational diffusion; A. Banderet (France), ultracentrifugal studies of cellulose glucolic acids; P. Kinell (Sweden), sedimentation in the ultracentrifuge; R. Signer (Switzerland), streaming birefringence in polydisperse media; P. Doty (United States), scattering of light from polymer solutions; M. Magat (France), viscosity studies on *GRS* solutions; G. Gee (Great Britain), statistical thermodynamics of gels; M. L. Huggins (United States), theory of rubber elasticity; P. Doty (United States), swelling of polymer networks; J. J. Hermans (Holland), deformation of cellulose gels; G. Champetier (France), solvation and swelling of cellulose derivatives; P. H. Hermans (Holland), crystalline and amorphous states in cellulose fibres; J. Chedin (France), ageing of nitrocellulose solutions; M. Mathieu (France), mechanisms of dispersion; P. Grabar (France), action of ultrasonics on macromolecules.

It is hoped to print these contributions in the January 1947 issue of the *Journal de Chimie Physique*.

The final session of the conférence was devoted to a discussion of the problems of publication and the possible formation of an international union of workers on the science of macromolecules. It was felt that the most desirable publication policy would involve an international journal of the following type. Each article would be printed in English and in either French, Russian or German according to the author's choice. Such a journal should include articles of general importance, articles based upon completed research, and reviews. Papers reporting the progress of research and of less general interest should appear in national journals and be abstracted in the international journal. The consummation of such a scheme as this is probably not possible without an international organisation. The informal offer to adapt the *Journal of Polymer Science* in the direction of these recommendations was welcomed.

Members of the conference were generally agreed on the desirability of a permanent international organisation capable of surveying the diverse scientific fields involved in the study of macromolecules. The administration of such an organisation, which would not be concerned with the technical uses of macromolecules, could perhaps be carried out by representatives of the member organisations; its duties should include: (1) active co-operation with the United Nations Educational, Scientific and Cultural Organisation; (2) planning and procuring financial aid for international conferences; (3) co-ordination of publication and subsidizing of an international journal; (4) facilitation of international exchange of research workers and substances; perhaps a store of highly purified macromolecules the physical properties of which had been carefully measured could be established.

All these discussions are preliminary and are reported for the purpose of initiating more universal consideration of these proposals. In order that the general feelings of workers in the field of macromolecules can become known, it is requested that those interested communicate with either Dr. M. L. Huggins, Kodak Research Laboratories, Rochester, N.Y., or Prof. Charles Sadron, Institut de Physique, 3 rue de l'Université, Strasbourg.

ELECTRODEPOSITORS' TECHNICAL SOCIETY

PROGRESS AND DEVELOPMENT

THE Electrodepositors' Technical Society was founded on December 9, 1925, so it has now come of age.

The inaugural meeting took place at the Northampton Polytechnic, Clerkenwell, which remained the Society's headquarters until very recently, when larger offices had to be secured to cope with the increasing membership. The Society, which first received the title "The Electroplaters and Depositors' Technical Society", was formed under the ægis of the Faraday Society, the secretary of which, Mr. F. Spiers, did much of the initial work in association with Mr. S. Field, at that time head of the Chemistry Department of the Northampton Polytechnic, Mr. W. James and Mr. W. E. Harris. The three latter individuals became the first president, honorary treasurer and honorary secretary respectively of the newly formed Society. Dr. S. Wernick, who took over the honorary secretaryship shortly afterwards, in 1927, and remained continuously in this office until 1945, has taken a prominent part in shaping the Society's policy. He is now its president.

The main object of the Society, namely, the publication and dissemination of information relating to electrodeposition and allied processes, has been faithfully carried out, as testified by the twenty volumes of *Transactions* which the Society has thus far published. Some hundreds of meetings have been held regularly, both at the London headquarters, and in Birmingham at the James Watt Memorial Institute, the headquarters of the Society's Midlands Centre. The recent War seems only to have given a further impetus to the Society's activities, and meetings continued to be held during the height of the bombing attacks on the capital and in the Midlands. The membership has steadily increased during this period, there being more than eight hundred active members enrolled at present.

The published papers are of a high standard and record the considerable development which has taken place in electrodeposition theory and practice. Much of the published work represents original research carried out during the past two decades in Government and industrial laboratories and research institutes. The work of the 'Woolwich' School, led by Mr. D. J. MacNaughtan (succeeded by Mr. A. W. Hothersall), occupies a prominent place in the Society's publications; much of the latter work was carried out in association with the British Non-Ferrous Metals Research Association. The publications prove convincingly that pioneer work in Great Britain on electrodeposition does not lag behind that of any other country in the world, despite the fact that, particularly in the United States, research facilities are superior, research being more generously endowed by an industry which is approximately some ten times the size of that of Great Britain. This record of continuous publication has been achieved by a relatively small society with slender financial resources, and is surely a striking testimony to the vigorous effort and ability displayed throughout by those honorary officials who have worked zealously in the Society's cause. Until recently the Society employed no paid clerical staff, practically the whole of its income being devoted to the issue of publications. In order to cope with the increased financial burden envisaged by future publications, the Council has lately opened a Publications and Development Fund, and donations to this Fund will be solicited from industrial undertakings which have directly or indirectly benefited from the Society's activities to date. It is hoped to raise a fund of £10,000 for this purpose.

Apart from its publishing activities, the Society has done much in disseminating information on electrodeposition and allied processes by organising exhibitions and conferences on numerous occasions; thus, in 1931, it organised the section on electrodeposition, electroplating, electro-forming, etc., at the Faraday Centenary Exhibition, which was held at the Albert Hall in London. In 1935, an Electrodeposition Exhibition was organised at the Science Museum, South Kensington; this proved to be one of the most comprehensive exhibitions dealing with all phases of pure and applied electrodeposition ever brought together in Great Britain.

The Society was also responsible for organising the First International Electrodeposition Conference, held in London in 1937; it was attended by leading authorities in this field of technology from many foreign countries, who contributed papers on different aspects of electrodeposition. Just before the outbreak of war in 1939, the American Electroplaters' Society followed this lead by holding the Second International Electrodeposition Conference in New York. The third has already been planned by the Electrodepositors' Technical Society, and will be held, it is hoped, in London in May of this year.

The Society has done much useful work in the field of standardization. Its permanent Standards Committee, under the chairmanship of Mr. E. A. Ollard, has worked unceasingly in the interests of laying down specifications to be used by the industry, covering not only the purity of chemicals and materials employed, but also the quality of the electrodeposits produced. One of the first tasks of this Committee was to revise the glossary of scientific and technical terms relating to electro-chemistry, etc., and thus produce the first comprehensive vocabulary, which has been of very material value to technicians ever since. With regard to standardization, one of the most recent specifications issued by the British Standards Institution, with which body the Society has worked very closely, covers the popular finishes, nickel and chromium plating. This is a signal achievement in view of the considerable controversy which arose on the possibilities of producing a specification which would be acceptable alike to technicians and industrialists.

At the official celebration of the Society's twenty-first anniversary, a large number of members and visitors met at the Northampton Polytechnic. Representatives of sister societies were present, and messages from the Chemical Society, Royal Institute of Chemistry, Institution of Electrical Engineers, Faraday Society, American Electroplaters' Society, Electrochemical Society, and a number of Continental bodies were read. Examples of some of the latest types of electrodeposits and some of the newly developed instruments for the control of electrodeposition were exhibited. Among the past presidents present were Mr. S. Field, Prof. R. S. Hutton, Mr. E. A. Ollard, Mr. A. W. Hothersall, Dr. H. J. T. Ellingham and Dr. J. R. I. Hepburn.

During the meeting, the president, Dr. S. Wernick, announced the Council's decision to institute a medal, to be known as the E.T.S. Medal, which would be awarded annually or at longer intervals to individuals who had performed outstanding service in the field of electrodeposition. It is hoped that the scope of the Medal will be international. It had been unanimously decided by the Council that the first recipient of the Medal should be the first president of the Society, Mr. Samuel Field. A scroll was formally handed by the president to Mr. Field as a token of the award, as it had not been possible to cast the Medal in time for the celebration; it is hoped that it will be possible to present the Medal itself on the occasion of the Third International Electrodeposition Conference.

PRESENT STATE OF SOME GERMAN MUSEUMS

By FRANCIS J. GRIFFIN

In *Nature* of May 11, 1946, p. 631, I gave some information on the condition of a number of German museums and their contents. I have recently heard from Prof. Martin Hering, of the Zoological Museum, Berlin, giving me more up-to-date information, which can be summarized here.

On January 1, 1946, Prof. Hering writes, the Russians returned the Zoological Museum to the University of Berlin, and it has now resumed work under its old title of Zoological Museum of the University. At the same time the hymenopterist, Prof. Werner Ulrich, was appointed director of the Museum, a post he holds simultaneously with that of director of the Zoological Institute of the Agricultural Faculty (formerly Agricultural High School) and that of director of the Institute of Agriculture. This appointment has met with general satisfaction.

The entomological collections of the Museum have survived the War undamaged in the cellars, with the exception of the Lepidoptera. This section is the most heavily damaged part of the Museum, but the roof has been repaired and the windows made weather-proof, partly with glass and partly with cardboard, so that damp can be kept out; the final drying out, however, must wait until next summer, since the walls are still too wet. For this reason, the Lepidoptera and Coleoptera will not be brought up from the cellars until next spring, and until then it will not be possible to see whether the conditions in the cellars have caused any damage. The collections have been there since 1943. Sampling suggests that no damage has been caused.

Dr. Deckert has returned from a prisoner-of-war camp and will resume his work shortly.

The library of the German Entomological Society is now in safety and no longer threatened by dampness; the damage is not so great as had been feared. All the Society's entomological periodicals were removed to the cellars, where they have suffered little, apart from a certain amount of mould on the bindings which is easily removed. Unfortunately, the Society has still not obtained permission to resume its activities. At the instance of the British Military Authority, a request was made in April to the Berlin Town Authority (*Magistrat*) for permission to start up again, but no answer had been received when writing. Prof. Hering adds that this is the more regrettable since the Society was not involved in Nazi politics and refused to eject its Jewish members.

There is good news of Prof. Hering's famous "Minen-Herbarium". After having been plundered, it was largely brought together again by the schoolteacher of the town to which it was sent, and is now restored to its rightful owner. Most of the lost specimens have been replaced, and Prof. Hering is now able to work again at his chief subject. Unfortunately, a few unique specimens are lacking. Of the 18,000 insects bred from the leaf-mines which were removed to the air-raid shelter in the Wilhelmsplatz, all have safely survived, including all the types.

Dr. Kaestner has written that the greater part of the surviving entomological material from the Stettin Museum has now been removed to Lublin. Dr. E. Urbahn, the lepidopterist, is not dead, as was thought, but is living at Zehdenick, near Berlin. His collection, which was housed in the Stettin Museum, was, however, destroyed before the removal of the latter.

The dipterist, W. Hennig, formerly at the German Entomological Institute at Dahlem, is at present working at the Zoological Institute of the University of Berlin.

The German Entomological Institute was, as I have already reported, evacuated to Blucherhof, Post Vollratsruhe, Mecklenburg, where it, and the library, is undamaged. Dr. Sachtleben is still director, and the Institute is now united with the Biologisches Zentralanstalt (formerly Reichsanstalt).

R. Friedlander and Sohn, booksellers and publishers, have resumed business under their own name, and their present address is Dorotheenstrasse 75, Berlin.

Max Gaede, collaborator in the Seitz book, died last spring, and K. M. Heller, coleopterist and Rhynchophora specialist, is also dead. Dr. Sick, a collaborator in Seitz's book, and latterly editor of the Geometridæ, is unable, for reasons of health, to continue work.

The publishing house of Gustav Feller, of Neubrandenburg, has been completely burned out, and the whole stock of the "Catalogus Lepidopterorum" and all the other catalogues of this publisher, as well as Hering's "Blattminen Mittel- und Nordeuropas", is lost.

Prof. E. T. Titschack, formerly of the Hamburg Museum, was a Nazi and now lives near Bitterfeld.

Of the large work, "The Zoology of Peru", everything not already distributed is destroyed.

H. G. Amsel, microlepidopterist, of the Bremen Museum, was a Nazi and has been turned out of the Museum.

Klaus Günther, orthopterist, of Dresden, is alive, as is Prof. F. Peus, dipterist, who is now entomologist at the Museum in Munster, in Westphalia.

The following are also alive: Prof. Ferdinand Pax, formerly of Breslau and now in the Harz; Prof. Max Draudt, successor to Seitz in the editorship of the "Grossschmetterlinge der Erde"; and Prof. K. Escherich, formerly of Munich, now near Tegernsee.

Dr. Riehm, president of the Biological Central Station for Agriculture and Forestry (formerly "Reichsanstalt") in Dahlem, has been removed as a Nazi, and his successor is Dr. Schlumberger; while the present lecturer at the Agricultural Faculty of the University of Berlin is Dr. Fritz Zimmermann, formerly lecturer in entomology at Tetschen in Czechoslovakia and a microlepidopterist.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, January 27

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. A. Dickson Wright: "The Advances of Modern Surgery" (Cantor Lectures, 1).

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "National Certificates and their relation to the Needs of Industry" (to be opened by Mr. S. E. Goodall).

Society of Chemical Industry, Manchester Section (joint meeting with the Manchester Section of the Institution of the Rubber Industry, at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. F. A. Jones: "The Chemistry and Technology of Organo-Silicon Compounds".

Tuesday, January 28

Institute of Physics, Electronics Group (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. H. S. W. Massey: "Semi-Conductors".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. P. H. J. Johnson: "The Principles of Manual and Automatic Telephone Exchanges".

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. W. C. Fahie: "Some Applications of Electronics in the Iron and Steel Industry".

Wednesday, January 29

Textile Institute (at the University, Leeds), at 10.30 a.m.—Conference on "Modern Methods of Single Fibre Testing".

Physical Society, Colour Group (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. H. D. Murray: "The Use of Colour in Factories".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Mr. Walter C. Puckey: "Economic Reconstruction, 2, Scientific Approach to Labour Problems".

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. E. Capstick: "The Nation's Milk Supply and its Best Use".

Textile Institute, Midlands Section (at Coventry), at 7 p.m.—Mr. L. H. C. Tippett: "Quality Control in the Textile Industry".

Thursday, January 30

Imperial Institute, Mineral Resources Department (in the Cinema Hall, Imperial Institute (East Entrance), South Kensington, London, S.W.7), at 3 p.m.—Mr. J. H. Harris: "A Metallurgist in Tanganyika".*

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. D. J. Finney: "Principles of Biological Assay".

Chemical Society, Sheffield Section (joint meeting with the Sheffield University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. B. Speakman: "Some Relationships between the Structure and Properties of Natural and Synthetic Fibres".

Institution of Electrical Engineers (at Savoy Place Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. H. A. Carr: "The Teaching of the Principles of Electrical Machine Design".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Air Marshal the Hon. Sir Ralph Cochrane, K.B.E.: "War-time Developments in Air Transport".

Royal Photographic Society, Scientific and Technical Group (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Mr. N. McQueen: "Animation in Scientific Films".

Society of Dyers and Colourists, Bradford Junior Branch (at the Technical College, Bradford), at 7.15 p.m.—Mr. E. Yeadon: "Cotton Dyeing".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in the Social Sciences" (Speakers: Prof. Michael Poston, Prof. T. S. Simey and Prof. S. Zuckerman, F.R.S.).

Pharmaceutical Society, Manchester, Salford and District Branch (in the Lecture Theatre, St. Mary's Hospital, Manchester), at 7.45 p.m.—Mr. R. N. Bomback: "Modern Development in Photography".

Friday, January 31

Chemical Society, St. Andrews and Dundee Section (in the Chemistry Department, University College, Dundee), at 5 p.m.—Dr. W. G. Campbell: "Modern Trends in the Chemical Utilisation of Wood".

Physical Society (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Edward Appleton, F.R.S., and Mr. R. Naismith: "The Radio Detection of Meteor Trails and Allied Phenomena"; Mr. J. S. Hey and Mr. G. S. Stewart: "Radar Observations of Meteors"; Dr. E. Eastwood and Mr. K. A. Mercer: "A Study of Transient Radar Echoes from the Ionosphere including Observations made during the Solar Eclipse of July 1945"; Dr. A. C. B. Lovell, Mr. C. J. Banwell and Mr. J. A. Clegg: "Radio Echoes from Meteors".

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. Ad. Meyer: "Marine Gas Turbine".

Royal Statistical Society, London Group of the Industrial Applications Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Dr. B. P. Dudding: "Control Charts Applied to Sales Data".

Manchester Statistical Society, Industrial Group (at the Manchester Society of Architects, 16 St. Mary's Parsonage, Deansgate, Manchester), at 6.45 p.m.—Dr. J. M. Rodgers: "Significance in the Interpretation of Test Data".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. K. Rideal, F.R.S.: "Thin Films on Water".

Saturday, February 1

Institute of Physics, South Wales Branch (at University College, Cardiff), at 3 p.m.—Dr. L. J. Comrie: "Some Applications of Calculating Machines".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physiology, and a Lecturer in Physics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (January 31).

Principal of the Royal Technical College, Salford—The Correspondent to the Governors, Education Office, Chapel Street, Salford, Lancs. (February 1).

Chair of Mathematics tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 4).

Lecturer in the Electrical Engineering Department, South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (February 8).

Teacher of Physics up to H.N.C. standard—The Principal, Technical College, Corporation Street, Preston (February 8).

Teacher of Zoology and Botany for Day and Evening Classes at Norwood Technical Institute, Knights Hill, London, S.E.27—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (February 8).

Senior Lecturers and Lecturers in Science (Biology and General Science) and Mathematics at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1780 (February 12).

Forest Entomologist (male) at the Forest Research Station, Alice Holt, Farnham, Surrey, under H.M. Forestry Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1657.A (February 14).

Physicists or Electrical Engineers for research and development work on telecommunications, radar and supersonics—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting A.6/47.A (February 14).

Principal Scientific Officer for research in animal nutrition with special reference to the metabolism of ruminants—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (February 15).

Lecturer in Mathematics—The Registrar, College of Technology, Manchester 1 (February 17).

Regius Professor of Physiology at Glasgow University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (February 20).

Lecturer (part-time) in Psychology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (February 20).

Lecturer (junior) in the Physics Department—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.2 (February 21).

Senior Lecturer in Genetics, a Lecturer in Horticulture, and a Senior Lecturer in Rural Sociology and Head of the Department of Economics and Rural Sociology, at the Canterbury Agricultural College, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.2 (February 25).

Senior Lectureships (2) in Psychology (one in Psychopathology and the other in Industrial Psychology), and Lectureships (2, temporary) in Psychology (in the field of Industrial and General Experimental Psychology), in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.2 (February 25).

Psychologist (temporary) at the Civil Service Selection Board, Stoke d'Abernon—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1779 (February 28).

Secretary and Administrative Officer—The Director of Research, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon, Surrey (February 28).

Readership in Organic Chemistry tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 5).

Anatomical Research Fellowship—The Secretary, Zoological Society of London, Regent's Park, London, N.W.8 (April 1).

Senior Assistant in the Department of Civil and Mechanical Engineering, a Senior Assistant in the Department of Chemistry, a Lecturer in Chemistry, and a Lecturer in Geography—The Principal, Technical College, Queen Street South, Huddersfield.

Research Worker to investigate the mechanism of learning in various animals (and in the first instance in Octopus)—The Secretary, University College, Gower Street, London, W.C.1.

Professor of Pure and Applied Mathematics in the Royal University of Malta—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

PROFESSOR OF PHYSIOLOGY—The Bursar, Royal Veterinary College, Royal College Street, London, N.W.1.

SECRETARY-EDITOR—The Hon. Secretary (Business), Physical Society, 1 Lowther Gardens, London, S.W.7.

JUNIOR DEMONSTRATOR OF PHYSICS—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Ministry of Health: Nurses Salaries Committee. Revised Recommendations regarding Certain Grades of Nurses. Nurses S. C. Notes, No. 12. Pp. 20. 4*d*. net. Nurses S. C. Notes, No. 13. Pp. 10. 2*d*. net. (London: H.M. Stationery Office, 1946.) [910

City and Guilds of London Institute: Department of Technology. Report on the Work of the Department for the Year 1945. Pp. 72. (London: John Murray, 1946.) 1*s*. net. [910

Ministry of Fuel and Power: Safety in Mines Research Board. Paper No. 104: Intrinsic Safety of Electrical Apparatus; the Minimum Igniting Current in relation to Circuit Constants. By G. Allsop, E. M. Guénault and A. D. I. Nicol. Pp. ii + 15. (London: H.M. Stationery Office, 1946.) 6*d*. net. [910

Scottish Society for Research in Plant-Breeding. Report (abridged) by the Directors and Report by the Director of Research. Pp. 42. (Edinburgh: Scottish Society for Research in Plant-Breeding, 1946.) [910

Department of Scientific and Industrial Research: Fuel Research. Experiments on Coking Practice: the Effect of Type of Oven upon the Properties of the Coke. Pp. iv + 30 + 41 plates. (London: H.M. Stationery Office, 1946.) 4*s*. net. [910

City of Manchester Public Libraries. Annual Report of the Committee, 1945–1946. Pp. 39. (Manchester: Central Library, 1946.) [910

Association of Special Libraries and Information Bureaux. Report of ASLIB Meeting on Indexing and Filing of Unpublished Material. Pp. 36. (London: Association of Special Libraries and Information Bureaux, 1946.) 3*s*. to Members; 4*s*. to non-Members. [910

British Electrical and Allied Industries Research Association. Annotated List of Published Reports. Pp. 112. (London: British Electrical and Allied Industries Research Association, 1945.) 5*s*. [910

Catalogue of Films of General Scientific Interest available in Great Britain. Compiled by the Scientific Film Association. Pp. 188. (London: Association of Special Libraries and Information Bureaux, 1946.) 5*s*. [910

Scientific Instrument Manufacturers' Association of Great Britain, Ltd. Handbook, with Classified Index of Instruments. Pp. 48 + 73. (London: Scientific Instrument Manufacturers' Association of Great Britain, Ltd., 1946.) [910

Forestry Commission. Leaflet No. 14: The Phomopsis Disease of Conifers (*Phomopsis pseudotsugae* Wilson.) Revised edition. Pp. 4. (London: Forestry Commission, 1946.) [910

Society for Freedom in Science. Occasional Pamphlet No. 5: The Future of Science and Technology. By N. S. Hubbard. Pp. 16. (Oxford: Dr. J. R. Baker, University Museum, 1946.) 1*s*. 6*d*. [910

British Rubber Producers' Research Association. Publication No. 70: Kinetic Studies in the Chemistry of Rubber and related Materials, 1, The Thermal Oxidation of Ethyl Linoleate. By J. L. Bolland. Pp. 20. (London: British Rubber Producers' Research Association, 1946.) [910

Agricultural Research Institute of Northern Ireland. Nineteenth Annual Report, 1945–46. Pp. 32. (Hillsborough, Co. Down: Agricultural Research Institute of Northern Ireland, 1946.) [1010

British Standard 7: 1946. Rubber Insulated Cables and Flexible Cords, including Supplement on the Use of Polyvinyl Chloride Compounds as an Alternative to Vulcanised Rubber. Pp. 56. (London: British Standards Institution, 1946.) 3*s*. 6*d*. net. [1010

Other Countries

Caribbean Commission: Committee on Agriculture. Nutrition, Fisheries and Forestry of the Caribbean Research Council. Crop Inquiry Series, No. 1: Livestock in the Caribbean. Pp. xi + 158. Crop Inquiry Series, No. 2: Grasses and Grassland Management in the Caribbean. Pp. ix + 68. (Washington, D.C.: Caribbean Commission, 1945.) [910

Imperial College of Tropical Agriculture: Low Temperature Research Station. Memoir No. 22: Studies in Tropical Fruits, 16, The Distribution of Tannins within the Banana and the Changes in their Condition and Amount during Ripening. By H. R. Barnell and E. Barnell. Pp. 77–100. (Trinidad: Imperial College of Tropical Agriculture, 1945.) [910

Dominion Museum Records in Entomology. Vol. 1, No. 3: A New Spider of the Family Archaeidae from New Zealand. By C. L. Wilton. Pp. 19–26. Vol. 1, No. 4: Collembola—Symphypleona from the Homer District, New Zealand. By Dr. J. T. Salmon. Pp. 27–62. (Wellington: Dominion Museum, 1946.) [910

Parliament of the Commonwealth of Australia. Nineteenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1945. Pp. 164. (Canberra: Commonwealth Government Printer, 1945.) 7*s*. [910

Smithsonian Miscellaneous Collections. Vol. 106, No. 9: The Species of Platycopia Sars (Copepoda, Calanoida.) By Mildred Stratton Wilson. (Publication 3853.) Pp. ii + 16. (Washington, D.C.: Smithsonian Institution, 1946.) [910

Department of Agriculture, Jamaica. Catalogus Insectorum Jamaicensis, Supplement: A List of the Mosquitoes found in Jamaica. By Rolla B. Hill and Claire McDowell Hill. Pp. 4. (Kingston: Government Printer, 1945.) [910

Government of Madras: Education and Public Health Department (Education). Administration Report for 1944–45 of the Government Museum and Connemara Public Library. Pp. 2 + 14. (Madras: Government Printer, 1946.) [910

Indian Forest Leaflet No. 93: The Efficiency of Enumerations. By Dr. A. L. Griffith. 12: One Species in a Mixed Forest (Teak in a Madras Moist Mixed Deciduous Forest); 13: Confirmation of the Chir (*Pinus longifolia*) and Sal (*Shorea robusta*) Data; 14: Summary of Indications. Pp. v + 14. (Dehra Dun: Forest Research Institute, 1946.) 5 annas: 6*d*. [910

Annals of the New York Academy of Sciences. Vol. 47, Art 2: Amino Acid Analysis of Proteins. By William H. Stein, Reginald L. Archibald, Erwin Brand, R. Keith Cannan, Hans T. Clarke, John T. Edsall, G. L. Foster, Stanford Moore, David Shemin, Esmond E. Snell and Hubert B. Vickery. Pp. 57–240. (New York: New York Academy of Sciences, 1946.) 2.25 dollars. [910

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 63: Technological Reports on Standard Indian Cottons, 1945. By Dr. Nazir Ahmad. Pp. iv + 107. 1.8 rupees. Technological Bulletin, Series A, No. 64: Technological Reports on Trade Varieties of Indian Cottons, 1945. By D. L. Sen. Pp. viii + 96. 1.8 rupees. (Bombay: Indian Central Cotton Committee, 1945.) [1010

Trinidad and Tobago. Administration Report of the Conservator of Forests for the Year 1945. Pp. 4. (Trinidad: Government Printer, 1946.) 12 cents. [1010

Department of Public Instruction: Technical Education Branch, New South Wales. Director's Annual Report of the Technological Museum for the Year ended 31st December 1945. Pp. 4. (Sydney: Government Printer, 1946.) [1010

Sveriges Geologiska Undersökning. Ser. C, No. 468: Studier över elementfördelningen i zinkbländen från svenska fyndorter. Av Olof Gabrielson. Pp. 52. 2 kr. Ser. C, No. 469: Arsenic-Cobalt-Nickel-Silver Veins in the Linksköld Copper Mine, N. Sweden. By Sven Gavelin. Pp. 18 + 11 plates. 0.50 kr. Ser. C, No. 470: A Nickel-Cobalt-Silver-Mineralization in the Laver Copper Mine, N. Sweden. By Olof H. Odman. Pp. 10 + 10 plates. 0.50 kr. Ser. C, No. 471: Dubbla moränan i Boliden. Av G. Lundquist. Pp. 10. 0.50 kr. Ser. C, No. 472: Determinations of the Magnetic Susceptibility of Ores and Rocks from Swedish Iron Ore Deposits. By Sture Werner. Pp. 79. 3 kr. Ser. C, No. 473: Om fynd av mammut vid Pilgrimstad i Jämtland. Av Oskar Kulling. Pp. 64 + 4 plates. 2 kr. Ser. C, No. 474: Arvidsjamfältet och dess förhallånde till omgivande berggrund. Av Erland Grip. Pp. 31 + 1 plate. 2 kr. Ser. C, No. 475: The Composition of Eckermannite and its Position in the Amphibole Group. By N. Sundius. Pp. 7. 0.50 kr. Ser. C, No. 476: Skredet vid Säveån den 18 januari 1945. Av Carl Caldenius. Pp. 14 + 3 plates. 0.50 kr. (Stockholm: P. A. Norstedt and Söner, 1945–1946.) [1010

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MAN-POWER FOR HIGHER ADMINISTRATION

SIR GODFREY INCE, permanent secretary of the Ministry of Labour, emphasized in a statement in London on January 9 that Britain faces a shortage in man-power likely to extend over several years. A growing appreciation of this fact is to some extent behind the concern which has been recently expressed, not merely at the absolute size of the Civil Service, but also at the relative proportion of the nation's man-power employed in the national and local government services. A total of more than two millions employed in such services and a ratio of one Civil servant to slightly fewer than three persons employed in the whole of the manufacturing industries of the country consorts ill with the over-riding need for increased production in almost every field. While not all the changes involved in the nationalization proposals of the Government affect appreciably the proportion of persons employed in production to those employed in distributive, clerical or administrative work, there are undoubtedly genuine misgivings on the part of impartial observers, as a House of Lords debate on December 18 testified, about the pace at which that programme is being executed and the consequent strain imposed upon the Civil Service.

Nor is this all. While some eight and a half per cent of the working population are engaged in local or national government service, the administrative class, on whom the main burden falls, has only increased to about 4,000, or double the numbers on April 1, 1939. It was argued by Lord Schuster that it is impossible from the reservoir of strength which we now possess to recruit sufficient people to the Civil Service fit to bear the responsibilities and to discharge the burdens which at present confront us. That point of view was not accepted by Lord Ammon, but neither he nor any other Government spokesman appears to appreciate the real dangers of overstraining the senior administrative officers of the Service. Under such conditions, it is idle to expect the constant scrutiny of methods and procedure necessary to eliminate redundant work and obsolete practice or controls which is essential to secure the utmost economy and efficiency in the use of staff.

Reports from the Select Committee on National Expenditure repeatedly stressed this point during the War; but while it is probably impracticable to increase very rapidly the administrative class of the Civil Service, too little attention is commonly given in discussions of the man-power situation to the way in which a shortage of persons qualified to fill professional and administrative posts may seriously impede the nation's recovery and its economic and social progress. The Barlow Committee on Scientific Man-power recognized that some order of priorities must be laid down; but neither in that Report, nor in the observations on it which the Parliamentary and Scientific Committee has issued under the title "Universities and the Increase of Scientific Man-power", is sufficient attention paid to the bearing of efficient management on the wise use of man-power. Its importance is well brought out in a broadsheet, "Britain's Need for Brain-power", in which *Planning* points out how efforts to increase the efficiency of industry and to develop the health, education and other social services are creating a demand for men and women with professional and administrative training much greater than could be met even if the pre-war level of recruitment had been maintained, and there had been no seven years gap in recruitment to some professions, as well as a drastic reduction in the number of those passing through the universities.

In such circumstances, it is essential not only to increase the supply of trained man-power as rapidly as possible and to see that qualitatively the increased supply is related to demand, but also to avoid so far as possible a wasteful scramble for the limited resources immediately available. Industry has already recognized that it would be unwise to attempt to attract immediately too large a proportion of scientific workers for the various research posts in the post-war development schemes planned; and the Government might well give more evidence of a similar wise restraint, and adjust the tempo of its plans for expansion of the research associations, for example, and for social services and nationalization, to the size of the scientific or administrative staff which can reasonably be expected to be available. So far there has been little sign that any attempt has been made to plan the use of Great Britain's limited resources of trained man-power to the best advantage, apart from the broad assessment of priorities in the Barlow Report.

While the *Planning* broadsheet stresses the need for such planning, it represents chiefly a careful survey of the future requirements of the professions and the upper ranks of industry, commerce and the public service, and of the arrangements desirable for recruitment. It is not easy to forecast the extent of the future demand of the Civil Service for trained men and women, and the figures circulated by the Chancellor of the Exchequer in Hansard of December 17 give little guidance. As already noted, the administrative class of 4,000 could probably with advantage be expanded, but even at 6,000—which is three times the pre-war level—would only provide a career for a comparatively small proportion of a doubled output of graduates. Some arts graduates may well find their way into the executive class, now numbering about 44,000 as against 19,000 in 1939; but the bulk of the 46,000 university students at present reading subjects other than pure or applied science must look elsewhere than to the Civil Service for careers.

On the other hand, the professional, technical and scientific full-time staff in the Civil Service numbered approximately 41,000 on October 1, as against 32,000 on July 1, 1945, and only 11,000 in 1939. Disregarding any such staff in the unanalysed total of 73,000 part-time workers on October 1, it would seem that the Civil Service is likely to absorb in future a considerably greater proportion than corresponds with the fifty per cent increase in scientific students at present in the universities, or than the hundred per cent increase contemplated, according to the Barlow Report, in university expansion during the next five years. When all allowance has been made for the elimination of unnecessary controls and for the improvement of operating methods and economy of man-power, the higher ranks of the Civil Service on both the scientific and non-scientific sides may fairly be expected to take rather more than a *pro rata* proportion of the increased output of graduates that would result from doubling the numbers coming from the universities.

It is, of course, much more difficult to estimate exactly the extent of the increased demand for arts graduates than that for graduates in science and technology. More graduates will be needed for local government services, for social work, for law and accountancy, and probably also for journalism, broadcasting, the theatre and the cinema; but whether industry and commerce will in fact take the greater number of arts graduates that they could, and should, is less certain.

Emphasizing that the community needs more men and women with the broad vision and lively critical faculty which a liberal education is designed to foster, *Planning* suggests that the output of arts graduates might be increased gradually to double the pre-war numbers by 1955, whereas that of science graduates, as the Barlow Committee concludes, should be doubled as soon as possible. For technologists, however, *Planning* is inclined to query the advisability of doubling the number. In some professions, such as medicine, an increase of about 20 per cent should be sufficient, while in others, such as dentistry, more than doubling has been recommended by the Teviot Committee.

Reviewing the professions generally, the *Planning* broadsheet points out that those for which forecasts have been made fall into three groups. First, there are those such as teaching, nursing and dentistry, in which a substantial increase in total strength is required and an increased annual intake throughout the years 1946–55. Next there are those such as accountants, company secretaries and librarians, in which the pre-war annual intake will probably be sufficient, once the fall in recruitment during the War has been made good. The third group comprises those professions, such as opticians, pharmacists and, possibly, solicitors, in which the total number is now sufficient and in which a smaller annual recruitment than before the War will be adequate.

One attempt to provide such a forecast has been made by the Manchester Joint Research Council. A survey of the Greater Manchester area attempts to assess the increase to be expected in the number of scientifically trained men employed by industry in the coming years as compared with 1939; it represents, in fact, something of the type of report on trends of employment which the Hankey Committee on Higher Appointments recommended should be issued from time to time by the Appointments Department of the Ministry of Labour. The university appointments boards might have undertaken similar surveys, but apart from that of the Cambridge

University Appointments Board on "University Education and Business" (see *Nature*, 156, 671; 1945), nothing has appeared. The Manchester Joint Research Council's report does, however, provide some means of gauging the extent to which recent developments in management, such as the formation of a Central Institute of Management, are likely to stimulate the demand for better trained men. The report shows that the greatest percentage increases in the number of firms employing graduates compared with 1939 were in textile manufacture (62 as against an overall of 32), engineering (35), chemicals (21), and textile finishing (18). The demand for graduates in industry is estimated at 80 per cent above the pre-war figures, and firms employing 85 per cent of these graduates expressed a preference for men who have had experience of research before entering industry. The biggest increase estimated was 100 per cent in chemicals, with 62 and 60 per cent in engineering and textile manufacturing, respectively. In more than 60 per cent of the firms offering employment to graduates, the higher executive posts are open to any scientific worker who shows himself to be competent and adaptable. More than 80 per cent of such firms have openings in plant control—works manager grades—and 55 per cent have a research and development department. Generally, firms employing large numbers of graduates prefer men with experience of research methods, whereas the smaller firms lay greater stress on technical training for graduate staff. While there is a sharp increase in the anticipated employment of graduates, the increase in the number of firms proposing to employ them is less marked, and it would appear that firms already employing them are readier to increase the employment of graduates than those who have not yet done so. The increase in the employment of graduates in scientific and technical capacities might have been expected, but that on the managerial side could not have been assumed with the same confidence.

It is essential to have more surveys of this kind and also to devise some system of forecasting future requirements. Means must also be found of ensuring that effect is given to the findings of such forecasts, so that we may be able to secure the fullest development and employment of the nation's reserves of brain-power. Both university expansion and the programme of nationalization, so far as they affect the Civil Service and demand the services of trained managers and administrators, must conform to, and be in step with, such findings.

Such forecasts of future requirements must form the basis of any recruitment policy; but once again *Planning* points out that Britain has the additional responsibility of training highly qualified men and women for service abroad. This applies not merely to administrators and business men but also to scientific workers, engineers and agricultural experts, who in recent years have gone out in increasing numbers to less highly industrialized countries. Moreover, it is important that university and professional training should be available in Britain to men and women from the Dominions and Colonies, and from foreign countries also. Further, it is essential to avoid regarding the problem exclusively from the demand side. A university education should provide not so much a professional technique as an intellectual training which is valuable in any walk of life. Training is not necessarily wasted when a man leaves the profession for which he has been trained, and it is important that allowance be made for transfers from one profession to another, and from a specialist to an administrative post.

DIAGNOSIS OF A FAILURE

Religion and Science

A Diagnosis. By the Rev. Dr. Charles E. Raven. (L. T. Hobhouse Memorial Trust Lecture No. 16, delivered on 1 May, 1946, at Bedford College.) Pp. 16. (Oxford: At the University Press, 1946.) 2*s*. net.

A RIGHT understanding of the causes and history of the conflict between modern science and the Christian religion is of primary importance for sociology to-day. It seems self-evident that scientific development has outrun ethical progress, and the consequences of this may be disastrous, though the situation admits of no simple remedy. The trouble is that though science can get along well enough in isolation from metaphysics, this is not equally the case with ethics, which seems to require for stability some sort of religious or philosophical background. The traditional European ethic has hitherto been based upon the Christian religion, and the decay of faith in that religion has been accompanied by signs of decay in the associated ethic.

Decay of faith in a religion may be due to some radical and incurable flaw such as the intellectual untenability of its fundamental tenets. Or, on the other hand, it may be due to faulty presentation of these beliefs, or to some twist or perversion which they suffered in the past but which might now be remedied.

Canon Raven takes this latter view, namely, that the present divorce between modern science and the Christian religion—a divorce fraught with serious consequences—is due to a twist of long standing, whereby a religion which originally recognized the worth and significance of Nature and history, came to adopt an attitude of contempt towards both. In his view the factor responsible for this perversion was the nature of the world into which Christianity was born. Its disillusion, corruption and brutality warped the new religion's development. There developed a tendency to contrast the supernatural with the commonplace; the wholesomeness of the Christian ethic became tainted with asceticism; eternal life became identified with the hereafter rather than with the here and now. God became again King and Judge rather than Father; the divinity and humanity of Christ were regarded as mutually incompatible, leading to the theological bankruptcy of Chalcedon. As for the creative conception of the Holy Spirit, this aspect of the divine nature was, so to speak, put into commission and became little more than a synonym for the supernatural prerogatives possessed and bestowed by the clergy. Thus between the ethos of the Gospels and that of the Creeds, there came about a change not only of climate but also of basic principle.

"The Gospels accept and sanctify the world of nature and history; the Creeds tend to renounce it:

the New Testament presents Christ as the consummation of the one natural-supernatural order; theological orthodoxy reshapes him as a divine intruder sent to rescue the elect from a world inevitably doomed."

St. Augustine embodied the pessimism of the time in treatises which shaped the future, condemning Nature as totally corrupt, and expounding as his philosophy of history a rigid dualism of natural and supernatural. Reinforced by the defeat of Pelagius, and coinciding with the growth of monasticism, Augustinianism shaped the Catholicism of Europe. Even in the brilliant zenith of medieval thought in the thirteenth century, the interest in natural phenomena which found religious expression in St. Francis, influencing also the Emperor Frederick II and the great schoolman Albertus Magnus, was powerless to affect the general outlook. The Englishman Roger Bacon was practically a unique phenomenon among the faithful, and nowhere in current views of Nature is there to be found any trace of first-hand observation or factual accuracy. Even the pictures in the herbals are almost invariably copies, debased and formal, of Græco-Roman originals. Thus the medieval Church was totally unable to adjust itself to the new ideas of the Renaissance.

The situation was that the magnificent system of Catholic metaphysics developed by the Schoolmen had been combined with a physics which were hopelessly defective; and the conviction had begun to prevail that problems could no longer be solved by appeal to authority, but that there was need for first-hand observation supplemented by experiment and formulated as hypothesis. The scientific movement, of which the foundation of the Royal Society in 1662 was a crucial point, reasserted the importance for philosophy and for religion of a sound and serious study of Nature and history. In the great days of the seventeenth century, there was a brilliant but brief period in which a new and satisfying interpretation of religion—a Christian synthesis worthy to replace the scholasticism of the Middle Ages—was foreshadowed and almost attained. Sir Thomas Browne in his "Religio Medici" and the Cambridge Platonists, Benjamin Whichcote, John Smith and others, expounded and developed it.

Yet the promise of this movement was not fulfilled, and Canon Raven examines the causes of failure. The scientific interest of the seventeenth century was predominantly biological in character. It was the study of life and the work of zoologists, botanists, physiologists and medical men. Thus the abstractness of the scientific outlook, its estrangement from life and culture, and its concentration upon mathematics, were by no means in evidence. Only with the coming of Newton did the narrowing of the field take place, and the Cartesian doctrine that science is mechanistic begin to prevail. Doubtless biological studies had reached a point when their further development must await progress in physics and chemistry, and it was perhaps inevitable that the Cartesian compromise (which was really a surrender) should be accepted, namely, that science should be content with the sphere of the material and that which is capable of exact measurement, while religion and the qualitative aspects of existence should lie outside its sphere.

What actually took place was a complete reversal of the medieval achievement. Then an ambitious metaphysical system was associated with grossly defective theories of the physical world. But now increasingly complete knowledge and control of the physical is associated with a metaphysic inadequate to the interpretation of life. Man's religious and moral experience is dismissed as illusory. Our development, like that of the medieval epoch, is lopsided, though our equilibrium wavers in an opposite direction.

Such is Canon Raven's diagnosis of the failure of our time to bring religion and science into line. Whether the new synthesis will come in time to save civilization from disaster remains to be seen.

J. C. Hardwick

BREEDING BIRDS OF DENMARK

The Breeding Birds of Denmark

With Special Reference to Changes during the Last Century. By Poul Jespersen. (Published by the Danish Section of the International Committee for Bird Preservation.) Pp. 79. (Copenhagen: Einar Munksgaard, 1946.) 6 Cr.

THIS small book is a brief account of the changes which have taken place in the breeding birds of Denmark during the last century and a half.

The first part is a systematic list of all the birds which nest or are said to have nested in Denmark during the period under review. There are a few remarks on their increase and decrease with suggestions as to the causes. The second part is devoted to lists of species which have changed their status or are sporadic or occasional breeders. Finally, there are a few pages on the distribution of a number of birds the nesting of which is restricted to certain parts of the area.

Of the 217 species said to have bred in Denmark, thirty must be eliminated, since the evidence is not above suspicion. These include the willow-tit, grasshopper-warbler, dipper, fieldfare, golden eagle and jack snipe. Such species as the roller, hoopoe and the larger birds of prey ceased to nest during the nineteenth century, and the evidence points to the fact that this was due to man's direct interference. More recently seventeen other birds have seriously decreased, and among them five birds of prey, some of which, no doubt, as the result of man's persecution, though in the case of the marsh harrier draining of breeding sites is the main cause. This, too, has affected the bittern, wood sandpiper and black tern, while the planting of heaths has restricted the nesting sites of the black-game and golden plover. The green woodpecker is included in this list and in earlier times was generally distributed, but is now restricted to parts of Jutland, where, however, it appears to be spreading, so the decrease may be merely temporary.

The white stork, which the fairy tales of Hans Andersen has made everyone associate with Denmark, is still common in many parts of Jutland, though seriously diminished in numbers. At one time there were two thousand breeding pairs in Denmark, but by 1930 these had diminished to 250. No one cause can be assigned for this decrease; but fortunately the picture is not quite so black as this suggests, since in recent years the numbers have increased and there are said to be 500 occupied nests.

The planting of large tracts has led to the increase of some birds, especially tits. The cole-tit, formerly known only as a winter visitor, is now a common nesting species, having spread from Germany. The central European race of the crested tit, *Parus cristatus mitratus*, was first found breeding in Jutland in 1890 and has since extended its range. It is reported nesting from N.E. Zealand, but whether the same race or the typical one is not known. The colonization of Denmark, however, by two separated races is known in the case of the bullfinch. The small European race, *P.p. minor*, began to spread into Denmark from the south some twenty years ago and nests in Jutland and Funen. In 1916 the northern bullfinch, *P.p. pyrrhula*, bred in Bornholm and in 1934 in Zealand. The spread of these two forms will be watched with interest.

Mr. Poul Jespersen has done his work well, and he Danish Section of the International Committee for Bird Preservation is responsible for the publicaion. If other sections of the International Committee would publish similar accounts they would be of great interest.

N. B. KINNEAR

SOCIAL BIOLOGY FOR SIXTH FORMS

An Introduction to Social Biology

By Alan Dale. Pp. vii+396. (London: William Heinemann (Medical Books), Ltd., 1946.) 15*s*. net.

THERE has been a marked tendency in recent years for educationists to review the contents of school curricula so as to bring them into closer relationship with everyday life. Biology, in particular, has been the target of much criticism on the ground that most school teaching was but a faint and distant reflexion of advanced university courses—or, as one critic put it, "the beverage of school children is Hentschel and Cook and water". Signs have not been lacking, however, that changes are on the way. Some School Certificate biology syllabuses have been 'humanized', the journal *Biology* has added "*and Human Affairs*" to its title; the columns of *Nature* have had articles discussing the significance of social biology and proposing the establishment of a National Institute of Social Biology; and now the social biology text-books are beginning to appear.

Mr. Dale's selection and treatment of material will meet with general approval. His main 'type' species is *Homo sapiens*; but he avoids the pitfall of narrowing biology into human anatomy and physiology. He gives much attention to the very important matters of sex and reproduction, but avoids the error of making 'social biology' a euphemism for 'sex instruction'. He discusses many aspects of human health and disease, but steers clear of morbid pathology. He relates the social life of humans to that of other animals, but avoids the temptation to make of man a magnified ant. In short, his material is of intrinsic interest and of social significance, and is built up into a systematic and scientific course of biology.

Many readers, however, will object on philosophical grounds to phrases such as "matter imbued with life", and to conceptions such as "a centralised pool of life, to which all life returns after the death of the host-matter" (p. 2). The final chapter on "The Nature of Life" does, however, present some alternative philosophical conceptions, although it makes no mention of the approach of dialectical materialism. Most readers, one hopes, will now be sufficiently aware of the harm that has been done by race theories to regret the use of the phrase "negroid and australoid races" (p. 42); while it is perhaps something of an exaggeration to assert that "the phenomenon of sex has basically nothing to do with reproduction" (p. 99). It is also somewhat surprising that a discussion of economic–demographic problems leads to the conclusion that "The ideal would be to have the bigger families born to parents of the upper classes and the smaller families in the lower classes", rather than that wealth should be redistributed.

Despite these and other criticisms, however, this is a book to be welcomed. It is well written, attractively produced and excellently illustrated—and it should go far to answer those critics who have claimed that courses in social biology would be merely 'soft options' for those who could not face the more academic courses.

CYRIL BIBBY

LIFE OF SPINOZA

Spinoza

Portrait of a Spiritual Hero. By Rudolf Kayser. Translated by Amy Allen and Maxim Newmark. Pp. xix+326. (New York: Philosophical Library, Inc., 1946.) 3·75 dollars.

THE author of this book allows himself the liberties of the novelist. He is omniscient and omnipresent. He knows Spinoza's private thoughts and how he looked on occasions when he was quite alone. No questions about authenticity of evidence trouble him. All this would have mattered little had he possessed the imaginative insight and power of expression which can justify such flouting of the rules. As it is, the book is neither reliable biography nor a living picture of a personality. It is not without value. Spinoza's stature is so great that it would need a very bad writer to shut him out of sight altogether. Mr. Kayser gives a great deal of useful information about the circumstances of Spinoza's life and about his contemporaries. The excursions into legend do not seriously affect the general tenor of the narrative, though they do throw doubt on the author's critical capacity.

Our main source of information about Spinoza is the short biography by Colerus, which occupies, in the English version and apart from polemical passages, barely twenty pages in the late Sir Frederick Pollock's book. As a good Lutheran, Colerus is shocked at Spinoza's heresies and says so explicitly and in no measured terms. But as an honest man who knew Spinoza personally he is equally shocked at the silly malicious gossip about him, and he writes in order to stop slanderous tongues from wagging. They went on wagging for about a century, but they stopped at last, and now his testimony remains as almost the only valid contemporary record. Colerus was not an artist in words and was something of a pedant, like many other Germans. But he had positive qualities not too common among people of any nation; he loved the truth, and knew a good man when he saw him. Thus we can see a great deal of the personality of Spinoza through his bald sentences. Spinoza is a supreme example of honesty and courage; the perfect model of the wise man of Stoic theory, who really lives up to his philosophy. He shows that it is possible, by accepting all events equally as inevitable, for a man to be so indifferent to the worst that circumstance or human malice can do, that in effect he becomes the master of circumstance and malice is disarmed against him. Spinoza is also the only philosopher known to history who earned an honest living by the work of his hands. A. D. RITCHIE

ADVANCED THEORY OF STATISTICS

The Advanced Theory of Statistics
By Maurice G. Kendall. Vol. 2. Pp. vii+521. (London: Charles Griffin and Co., Ltd., 1946.) 50*s.* net.

THE first volume of this work, reviewed by Prof. R. A. Fisher in *Nature* of October 16, 1943, covered the subjects of frequency distributions and their properties; theories of probability and sampling and the sampling distributions to which they lead; and the theory of correlation. Chapter 12 on the χ^2 distribution was described by the author as something of an intrusion. A new edition of volume 1 in 1945 had no alterations of substance. The present very welcome volume 2 falls into five sections, dealing with estimation, the theory of statistical tests including the analysis of variance, regression analysis, the design of statistical inquiries, and the analysis of time series.

Prof. A. D. Ritchie, in *Nature* of November 2, 1946, p. 639, has drawn a distinction between the man of science and the technologist which can, I think, be applied, with a difference, to mathematicians. Some, if they carry out calculations, do so as practice for the sake of understanding. Others, though they must understand first, do so for the sake of the practical application. I may perhaps speak for those who want to apply statistical methods in various fields—in my case experimental psychology and education—but want also to understand them, indeed become interested in them for their own sake. Such must welcome Mr. Kendall's book warmly, and perhaps especially this second volume, in which Chapters 23 and 24 on the analysis of variance, and 25 on the design of sampling inquiries, are of peculiar interest to them.

In agricultural experiments, properly designed, there seldom arises the problem of "unequal numbers in subclasses" (par. 24.6 *et seq.*). But in all sociological experiments, numbers in subclasses are liable to inequality. Absences from school affect one class more than another. An island population does not fall into occupational or racial classes of equal size. So the procedures to be adopted with 'non-orthogonal' data (pp. 220–9) are of importance. I am sorry there is only a page and a half (pp. 262–3) about 'confounding'. It is very useful, however, to have everything in one book, and the examples and exercises (easy and difficult) are an admirable training and clarification.

Mr. Kendall describes the work on canonical correlations of Hotelling and others, on pp. 348–58. Their perusal reminded me of a problem which I posed a few years ago, to which I have not received an answer. In work with intelligence tests the canonical correlation technique appears as the problem of finding sets of weights to apply to two batteries of tests so that the correlation coefficient of the two weighted scores is a maximum. I applied this in 1940 (*Brit. J. Psychol.*, **30**, 358) to the problem of finding what weights would maximize a battery's reliability, that is, its correlation with a duplicate battery. These weights will, however, be different from those which cause this battery to give the best prediction of some 'criterion', such as future success in a secondary school, and straining after reliability may spoil prediction, and vice versa. The problem was to find weights which would make reliability equal to prediction and both as large as possible under this condition. In simple cases a solution can be found. But what is the general solution ?

Students who are not primarily mathematicians very much need and welcome preliminary genera explanations of the logic and purpose of the procedures to be proved and used in the succeeding pages, and some of them find geometrical analogies helpful. Given such assistance, they are able to follow the algebraic work more easily, or at leas to appreciate its general trend, and to feel able to accept, not quite blindly, the formulæ arrived at.

Such assistance is not wanting in Mr. Kendall's volume—I may instance pp. 269–72 with the diagram, at the outset of the discussion of the genera theory of significance tests, and the diagrams of confidence belts on pages 68, 69 and 77. In the latter I suggest the addition in dotted lines of the whole sausage-shaped region of acceptance, of which the shaded area is a section.

The theory of probability has always been an arena for controversies and even quarrels. Mr Kendall has refused to take sides in present-day disputes, but has objectively described both points of view. About the different approaches to the treatment of confidence intervals and fiducial inference, differences which so easily escape from one's mind even when one has again and again grasped them fleetingly, he has written two admirably lucid chapters, and has had them read by Prof. Egon Pearson and Prof. R. A. Fisher respectively to ensure that he has at least not misrepresented them. To the outsider, now one and now the other view seems the better. In sociological work, it is important not merely to consider the possibility of a hypothesis being the true explanation, but also its relative standing when compared with alternatives. Neyman and Pearson make just this point, and in addition to defining regions within which we reject a hypothesis because the odds are so and so that the data did not arise from it (of which regions there may be many) they choose among them that region which minimizes the chance of accepting the hypothesis when it is false.

On the other hand, the Behren's test does not hold in the theory of confidence intervals, and the reply that "some questions may not have an answer" seems scarcely sufficient. Then Kendall protests that we can never test a fiducial distribution by drawing samples. But we can set up some apparatus corresponding to the value of θ and find experimentally the proportion of samples which give rise to t. Then we can change θ and repeat; and so on. Surely this is an experimental frequency distribution.

Many will look forward to the future publication which Mr. Kendall half promises, in which he hopes to show that all these disagreements are more apparent than real.

The book is beautifully printed and the proofreading has been excellent.

GODFREY THOMSON

BIOCHEMICAL RESEARCH AT OXFORD UPON MUSTARD GAS

By Prof. R. A. PETERS, F.R.S.

CONCURRENTLY with the research upon arsenical vesicants which led to *BAL*[1], a biochemical attempt was initiated at the outbreak of the War in 1939 by the writer and directed in the Biochemical Department, Oxford, for the Ministry of Supply, with the object of finding either a better compound to act as a 'chaser' to follow quickly and to remove unreacted mustard gas in the skin, or an antidote capable of reversing the combination of mustard gas with the skin constituent. This review deals with the salient features of the work of the Oxford sub-group (J. St. L. Philpot, A. G. Ogston, E. R. Holiday and L. A. Stocken); for other related work see the recent reviews of M. Dixon and D. M. Needham[2], and of A. Gillman and F. S. Phillips[3].

Whatever view be taken as to the physiological and pathological changes involved in vesication, the first step is a biochemical change, better called a 'biochemical lesion'. Some indication of our attitude to earlier hypotheses of the action of mustard gas is necessary to explain our mode of attack. Two outstanding points in regard to its action upon skin are: (*a*) the minute amounts which will cause erythema and vesication; and (*b*) the delay in appearance of erythema and other pathological signs.

Much earlier (1923–25) Peters and Walker[4,5] had rejected both the theory that mustard gas poisoned by liberation of intracellular acid, and also the 'sulphone' hypothesis based by Flury and Wieland—with little evidence—upon the idea that mustard gas was first converted into dichlorodiethylsulphone by oxidation in the skin. Peters and Walker proved that, when suitably applied, dichlorodiethylsulphone was as vesicant as mustard gas, and the Chemical Defence Experimental Station at Porton showed that it had a high toxicity. But the sulphone hypothesis was nevertheless untenable for at least two reasons: (*a*) because no dichlorodiethylsulphone could be recovered from skin treated with mustard gas; and (*b*) because mustard gas failed to abolish the fixed —SH reaction in skin tissue, which rapidly vanished upon treating with the mustard gas sulphone *in vitro*. Applying the work of Hopkins and Dixon[6] upon the fixed —SH group in muscle tissue, they also found that other skin vesicants, diphenylchlorarsine and allyl isothiocyanate, abolished the nitroprusside reaction given by the fixed —SH group in skin, muscle and tracheal tissue.

No support could then be obtained for a third hypothesis, namely, that mustard gas attacked an enzyme; later, Peters[7] revived the enzyme hypothesis by showing that dichlorodiethylsulphone (as well as arsenite) had a selective action upon the brain pyruvate oxidase system, resembling that produced by aneurin deficiency; in particular, the oxidation of lactate was inhibited selectively at the pyruvate stage by concentrations of dichlorodiethylsulphone (0·087m*M*.) which left (by inference) the cytochrome and lactate dehydrogenase systems intact. Since the action resembled iodoacetate, he was led to suggest that the vesicant action was due to attack upon the same enzyme. This work was carried out independently and about the same time as work in relation to tumour glycolysis by Berenblum, Kendall and Orr[8], who found a more marked action upon glycolysis than upon respiration *in vitro* with mustard gas, dichlorodiethylsulphone and cantharidin; they did not relate this to individual enzymes.

Our work in the War started with the idea that the pyruvate system was specifically poisoned; though an N-group could not then be absolutely excluded, and in spite of earlier contrary evidence, it was thought that, as with the arsenicals, the site of attack must be an —SH group, because mustard gas so readily attacked simple thiols. It was clear that knowledge of the biochemical components affected, and of the chemical reactions involved, was essential.

Rational progress was soon made upon the mechanism of chemical action of mustard gas (Holiday, Ogston, Philpot and Stocken[9]; earlier findings upon the kinetics of hydrolysis at physiological *p*H (Peters and Walker[4]) were interpreted upon Ingold's theories (see Watson, H. B.[10]) as indicative of an SN_1 reaction; it was realized that the compound was a remarkable alkylating reagent, active at room temperature; by a generalization known as the 'competitive theory', the groups most likely to be selected for attack by replacement reactions in a mixture could be predicted (Ogston[11]). The competition factor (*F*) of a reagent was defined as the ratio of the rate of its reaction to that of water, when the concentration of the reagent is 1 equivalent per litre; the reaction with water is:

$$S(C_2H_4Cl)_2 + 2H_2O = S(C_2H_4OH)_2 + 2\,HCl.$$

COMPETITION FACTORS

Thiophosphate	7×10^4	*BAL* $7{\cdot}8 \times 10^2$
Thiophosphonates (di)	$1{\cdot}0 \times 10^4$–10^5	amino $1{\cdot}8 \times 10^1$
Thiosulphate	$2{\cdot}7 \times 10^4$	carbonyl $1{\cdot}0 \times 10^1$
Diethyldithiocarbamate	$3{\cdot}4 \times 10^4$	phosphate $7{\cdot}5 \times 10^1$
Cysteine	$1{\cdot}2 \times 10^3$	

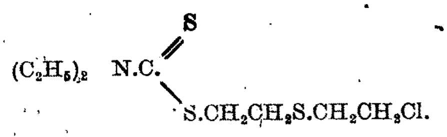
The table gives briefly some of the competition factors for different types of substance. (Similar work was started independently later by Linstead and colleagues in the United States.) Compounds likely to act as 'chasers' could now be developed upon a plan. It will be noticed how much more reactive were some complex thiols, for example, diethyl dithiocarbamate and the dithiophosphonates; the latter were new compounds specially developed for this research by Philpot and Stocken. Of all competitors, though of no value for skin treatment, they proved much the most promising; being comparatively non-toxic, they could be injected and were therefore suitable for dealing with mustard gas in the circulation; they could protect rats as well as the brain pyruvate system against mustard gas; later this work was intensively developed by Rydon, G. R. Cameron and others at Porton. In spite of their theoretical advantages, in practice, injection of these compounds proved to give no longer interval for treatment than existing anti-gas measures, owing largely to the rapidity of fixation of toxic amounts of mustard gas in the skin (Fell and Allsopp, 1940, G. R. Cameron, H. M. Carleton and K. Harrison, 1940; H. Cullumbine, 1942, U.S. workers) and to the speed with which mustard gas enters the circulation. In this, earlier quantitative work by Holiday and Ogston[12] in rats was confirmed and extended by the radioactive technique then being developed by Wormall and his team at Cambridge, and afterwards extensively used in the United States and in Canada. From a different angle Stocken[13] also proved the rapidity of mustard gas fixation in human skin by showing that his new, highly penetrant and reactive chlorinating compound (N.dichlorethane sulphonamide) was not effective against skin contamination after five minutes.

As an extension of this work, Ogston[14] made the advance for kinetic theory in preparing for the first time the half-product of hydrolysis of mustard gas, β-chloro-β′-hydroxydiethylsulphide, $ClCH_2CH_2S.CH_2CH_2OH$: (this was also done independently at Sutton Oak). By its use he found finally that the second —Cl in mustard gas hydrolyses rather more quickly than the first.

In attempts to understand mustard gas effects in the cell, the competition theory is fundamental, because it predicts what groupings might be expected to be attacked; it also shows why there must be a more general alkylation of a variety of groups with increasing concentration.

Quite early we proved that the pyruvate oxidase system was almost as sensitive to poisoning by dichlorodiethylsulphone and divinylsulphone as to arsenic (Peters and Wakelin); though there was some correlation between toxicity to this system and vesication, this did not hold for mustard gas, to which the system was less sensitive. Mustard gas was scarcely toxic to the cytochrome and succinoxidase, lactate oxidase or amino-acid oxidase systems. The pyruvate oxidase system was sufficiently poisoned by mustard gas to be used as a convenient test for protective trials with the thiol compounds (Holiday, Ogston, Peters, Philpot and Stocken[15,16]).

There was followed at this stage an interesting potentiating action of diethyldithiocarbamate upon the action of mustard gas upon the pyruvate oxidase system, by which it became practically as toxic as the sulphones and the arsenicals. Found to be a property of some dithio compounds, the action was traced mainly to the toxic action of the half-product of combination[17], namely:



$$(C_2H_5)_2\ N.C\begin{matrix}\nearrow S\\ \searrow S.CH_2CH_2S.CH_2CH_2Cl.\end{matrix}$$

One explanation of this potentiation was that it converted a feebler attack upon some other grouping in the enzyme system into an attack upon the —SH group (Philpot). A paradox had developed; all the highest competing substances contained —SH groups; the pyruvate oxidase was proved to contain —SH groups, yet our older view that mustard gas did not attack the fixed —SH group appreciably appeared to be correct. Drs. Dixon and Needham[2], and colleagues, for example, who were then developing the hexokinase theory of mustard gas and of vesicant action which appeared to cover the facts better, obtained suggestions that an —SH group was not the site of attack. This showed clearly the marked difference between the action of the arsenicals and of mustard gas.

At this period, too, a study of the alkylation of kerateine by mustard gas (Peters and Wakelin[18]) showed that though some of the thiol groups were attacked, about three-quarters of the mustard gas had combined with other groups (much more detailed studies on proteins were made by Wormall's team[19]). Independently again, A. Pirie[6] found that collagen, comparatively free from thiol groups, combined with mustard gas. All this was evidence that, in spite of the reactivity of compounds like the thiophosphonates, the —SH groups were not so easily selected by mustard gas in the tissue. Indeed, our protective experiments *in vitro* on the pyruvate oxidase system had suggested that cysteine with comparatively low competition value was as effective in protection as highly competitive substances. For fundamental biochemical theory, these facts throw into relief the importance of understanding the reactivity of —SH groups attached to large molecules. Much evidence has now accumulated at Cambridge and in the United States that this vesicant attacks —COOH groups in proteins.

The practical failure of substances able to detoxicate mustard gas rapidly focused attention upon the possibility of removing the combined fragment. In regard to any thioether linkage formed (—C—S—C—) an interesting silver reaction was developed; if silver nitrate is added at room temperature at faintly acid *p*H to form a silver complex with some thioethers, and the *p*H then changed to faint alkalinity, the thioether may be decomposed with regeneration of the constituents (Peters and Wakelin and with Ford-Moore[3]); for example, in the case of the compound of cysteine and phenyl-β-chlorethylsulphone, the *p*H at which the splitting starts is about *p*H 7·8 (near that of the cell), and it was possible to isolate both split fragments. Curiously enough, the similar sulphide does not show this scission reaction; but it will do so if the sulphide is oxidized to the sulphoxide form. From a different aspect, similar results were reached in the United States. In regard to the labilization of a mustard gas fragment which has alkylated —COOH groups, Ogston had shown earlier that there was slow hydrolysis of the acetate at physiological *p*H, and Pirie that much of the mustard gas combined with collagen could be split in alkaline solution. It was found (Peters and Wakelin[21]; also work of Kinsey and Grant, and Bergman *et al.*[22]) that oxidation (presumably to sulphoxide) of the bound sulphur in mustard gas kerateine made the mustard gas fragment much more unstable, suggesting that much was combined with COOH. This appears to be a suggestive observation and is reminiscent of earlier biochemical work on labilizing groups in relation to enzyme action. The important point is that regeneration of cell constituents attacked by mustard gas at —COOH and —SH groups is not now absolutely inconceivable.

That poisoning of an enzyme can initiate vesication seems proved for the arsenicals; the theory of Dixon and colleagues[2] that mustard gas action is due to the initial poisoning of hexokinase is based upon its rapid poisoning of this enzyme *in vitro*. The outstanding difficulty in regard to this theory is that, *in vitro*, hexokinase is not immediately poisoned, which, though consistent with the slow appearance of erythema, is difficult to reconcile with cumulative histological evidence that mustard gas also makes an immediate attack upon skin. In searching for other interpretations, we made use of our studies on thermal burns (Beloff and Peters[23]), where we had found recently the liberation of a proteinase at an early stage from burned rat skin, owing presumably to a change in permeability. Similar experiments with mustard gas showed that within a short time of contamination there was a disappearance of proteinase, not due to inactivation by mustard gas; as in the case of thermal burns, it seemed that this might be responsible for the epidermal separation (Beloff, Peters and Wakelin[24]). In this connexion it was most pertinent that H. Cullumbine and H. N. Ryden[25] found that our proteinase could liberate leucotaxine from some proteins and so cause vasodilatation. These experiments have led us to doubt the enzyme theory for mustard gas, in the sense that this was the first constituent attacked with the lowest toxic concentration of mustard gas, and to believe that the first attack was upon the surfaces of skin cells; though even an attack on 'surface' enzymes is not quite excluded, it is possible that changes in cell permeability with a contingent dilution of cell constituents would be dangerous. This 'cell surface' hypothesis, making the action of mustard gas somewhat analogous to that in thermal burns, was reached from a different angle by Cori *et al.*[26], and was also the view of R. K. Cannan[27].

If this be indeed the first site of attack, we are still in ignorance of the constituent concerned. During the first nine months of the War, Dr. Berenblum and Miss Schontal (Department of Pathology, Oxford) worked in parallel with our team and found that nucleoprotein in thymus extracts was powerfully and rapidly attacked by mustard gas. This would be in line with the cytotoxic action; for example, the formation of mutations (C. Auerbach and J. M. Robson[2]). At present there is a trend of biological opinion towards the idea that there is nucleoprotein in the cytoplasm; if some reactive nucleoprotein is situated in the interface, we should have a good working hypothesis for further studies. That points of fundamental scientific, in addition to practical, interest will repay further study seems reasonably certain, though they will have to be done by those who are not yet hypersensitive to its effects! A reagent capable of alkylating the nucleus at room temperature surely has great possibilities.

In conclusion, it is interesting to note that of the four biochemical lesions studied in the laboratory, two, namely those produced by aneurin deficiency and arsenicals, attack the pyruvate oxidase system. At present there is some support for the view that both heat and mustard gas appear to concentrate their initial attack upon the cell surface.

It should be recorded that a different approach was initiated by Dr. R. H. S. Thompson of this Department. In 1942[2] he found that the 'nitrogen mustards', ββ′-dichlorodiethyl-N-methylamine and trichlortriethylamine, are effective inhibitors of cholinesterase both *in vitro* and *in vivo*. Mustard gas also inhibited this enzyme but to a lesser extent. Certain of the systemic effects produced by these agents are muscarine-like in nature, so that a failure to hydrolyse liberated acetyl choline might well account, in part at least, for some of the pathological symptoms observed. But since it is clear that this is only one of several enzymic inhibitions produced by these compounds, it is not yet possible to formulate any definite relation of this inhibition of cholinesterase to the action *in vivo* of these vesicants. It may be recalled in this connexion that Cordier[5] has reported experiments upon alkaloid-like effects of mustard gas.

During the War, an independent study was made by Z. Bacq and his colleagues (see Z. M. Bacq[30]) of the effects of chemical warfare agents upon thiol compounds in relation to vesicant action.

We are indebted to the Director General of Scientific Research (Defence), Ministry of Supply, for permission to publish this work. As in the case of the work upon arsenicals, we are grateful to Mr. Davidson Pratt and his colleagues at the Ministry for their support, and to the staff of the Chemical Defence Experimental Station, Porton. We have also much appreciated discussions with Dr. Dixon and his team, as well as with others.

A reference thus, "Peters Report No. 1 (1940)", refers to a report submitted to, and given a restricted circulation by, the Chemical Defence Research Department of the Ministry of Supply in that year.

[1] *Nature*, **156**, 616 (1945).
[2] *Nature*, **158**, 432 (1946).
[3] *Science*, **103**, 409 (1946).
[4] *Biochem. J.*, **17**, 260 (1923).
[5] Government Reports.
[6] *J. Biol. Chem.*, **54**, 527 (1922).
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[8] *Biochem. J.*, **30**, 709 (1936).
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[10] Ann. Rep. Chem. Soc., 208 (1938).
[11] Peters Report No. 34 (1941).
[12] Peters Report No. 18 (1940).
[13] Peters Report Nos. 55 and 62 (1942).
[14] Peters Report No. 40 (1941).
[15] Peters Report No. 1 (1940).
[16] Peters Report No. 15 (1940).
[17] Peters Report Nos. 71 and 72 (1943).
[18] Peters Report No. 39 (1941).
[19] Banks, Boursnell, Francis, Hopwood and Wormall, see *Proc. Biochem. Soc.*, July 19, 1946.
[20] Peters Report No. 53A, and with Porton No. 53B (1942).
[21] Peters Report No. 87 (1945).
[22] By communication (1944).
[23] *J. Physiol.*, **103**, 461 (1945).
[24] Peters Report No. 90 (1945).
[25] *Brit. J. Exp. Path.*, **27**, 33 (1946).
[26] Cori, C. F., Colowick, S. P., Berger, L., and Slein, M. W., by communication (1943–45).
[27] Private communication.
[28] *Nature*, **157**, 302 (1946).
[29] Peters Report No. 63 (1945).
[30] *Enzymologia*, **10**, 48 (1941): see also *Experientia*, **2**, 349, 385 (1946).

MEDICAL ASPECTS OF MUSTARD GAS POISONING

By Dr. H. CULLUMBINE
Chemical Defence Experimental Station, Porton

MUSTARD gas, or 2, 2′ dichlorodiethyl sulphide, was first prepared by Guthrie in 1859, and he commented on its vesicant properties. It is, in fact, a very versatile agent, defiling all tissues with which it comes into contact, and it is potent in the vapour as well as in the liquid phase.

Mode of Penetration of the Skin

Mustard gas penetrates the skin rapidly; but there is a latent period of some hours, under temperate climatic conditions, before any macroscopic change is produced, and there has been much speculation on what is happening to the mustard gas during that time. The problem has been studied histochemically (Cullumbine, 1944) and by the use of mustard gas containing radioactive sulphur (Moritz, Henriques *et al.*, 1942–43). It would appear that 80–90 per cent of the mustard gas penetrating the skin passes rapidly into the circulation. Of that remaining in the skin, most (about 12 per cent of that penetrating) is rapidly fixed, possibly by combination with protein, and only a very small amount remains 'free'. This 'free' mustard gas does not exist in the skin of man except in the epidermis, and even this has disappeared within thirty minutes of contamination. No 'free' vesicant is demonstrable in the dermis even within five minutes of contamination.

The extent of vesication is proportional to the amount of 'fixed' mustard gas, and since 'free' mustard gas has only a transient life in the skin, we should expect any therapy based upon a reaction with 'free' mustard to be valueless unless applied very soon after contamination. Examples of such therapies are the reactive principles of British anti-gas ointments, which, even under temperate climatic conditions, suffer the limitation of being effective decontaminants for only a few minutes after the application of the mustard gas to the skin.

These ointments depend for their efficiency on the liberation of chlorine on the skin; but it has been shown (Cullumbine and Liddell, 1944), by histochemical means, that available or 'free' chlorine does not exist as such in the inuncted skin. The active principles of the anti-gas ointments do penetrate the skin only to be immediately reduced by the many unsaturated compounds present in the skin. Therefore, ointments depending for their efficiency on the liberation of chlorine in the skin are useless as late decontaminants for mustard gas; the only hope of preventing skin damage is by therapy which will reverse the mustard gas fixation and the physiological processes accompanying it.

Competitors

The 'fixed' mustard gas is probably held in the skin in combination with skin protein, for many workers have shown that mustard gas can react with a wide range of proteins (Berenblum, 1940; Wormall, 1940; Pirie, 1941; Peters and Wakelin, 1941; Northrop, 1942; Hellerman *et al.*, 1943; Cozan, Kenny and Grant, 1943). In fact, by substitution reactions involving the highly reactive β-chlorine atom, mustard gas can react in an aqueous phase with compounds containing the groups —SH, carboxyl, amino, hydroxyl, etc. (including proteins, amino-acids, nucleic acid, etc.), and its toxic effect has been assumed to be due to its reactivity in this fashion with one or more of the cell constituents (Ogston, 1942). Therefore, any reagent with itself an affinity for the β-chlorine atoms of mustard gas might be expected to be successful in preventing mustard gas 'fixation' or in reversing such 'fixation'. A representative selection of such compounds ('competitors') has been tested (Cullumbine and Rydon, 1944) on contaminated human skin with this end in view; they all proved less effective, under the conditions of test, than existing anti-gas ointments. The rationale of the use of 'competitors' for the treatment of mustard gas-contaminated skin assumes, of course, that the 'fixation' of the vesicant is reversible; Cullumbine (1944) and Kinney and Grant (1944), using animals and yeast cells respectively, have been unable to find any evidence for this assumption.

Leukotaxine

'Fixation' of the vesicant occurs very rapidly, but yet some hours may elapse before obvious reddening and vesication appear. This long latent period is of macroscopic significance only, and there is evidence that changes occur in the underlying tissues shortly after the mustard gas is applied. Thus Cameron and Short (1944) using rabbits, and Cullumbine (1944) in man, have shown that an increased capillary permeability occurs in the skin within a few minutes of contamination; at the same time, they have produced histological evidence of damage in the dermis and underlying structures 20–30 minutes after the application of mustard gas. The increased permeability and the early accumulation of leucocytes are apparently due to the formation of a factor similar to Menkin's 'leucotaxine'. This factor can be isolated quite early from mustard gas-contaminated skin and also from the blister fluids of several vesicants (Cullumbine and Rydon, 1943). Its formation is not specific to the action of mustard gas on the skin, since other vesicants and injuries can produce an apparently identical factor. The substance has been partially purified, and it appears to be a polypeptide of comparatively low molecular weight. Moreover, its ready production by the digestion of certain proteins suggests that it may be produced by the interaction of mustard gas and protein in the skin; the skin proteinase of Beloff and Peters (1945) may play some part in this formation.

Enzyme Systems

However, mere injection of the capillary permeability factor does not produce a vesicle. Therefore, some additional factor must be involved in the mechanism of vesication. Histological study has shown that the separation of the blister roof occurs by disruption somewhere around and along the epidermal–dermal junction. This separation probably occurs through the inhibition of certain enzymes (phosphokinases) which are necessary to cell life.

A whole host of enzymes can be inhibited by mustard gas if the conditions are sufficiently drastic, and such a general inhibition may be the cause of the necrotic action of mustard gas when applied to the skin in massive doses. However, under milder conditions, the action of the vesicant would appear to be more specific. Peters (1940) observed that the brain pyruvate oxidase system was inhibited by mustard gas and certain other vesicants, and this phenomenon has been used to measure antidotal effects too small to be detected easily *in vivo*. Dixon (1941) has also studied thoroughly a large number of enzymes. He has shown that there is a close relationship between vesication and the inhibition of glycolysis, and he has concluded that mustard gas inhibits a group of enzymes, the phosphokinases. Thus in the glycolysis system it inhibits the reactions for which the enzymes hexokinase and deutero-hexokinase are responsible. In addition, Dixon found that substances which poison hexokinase are all vesicant, and that substances which do not poison hexokinase are all non-vesicant. Again, there is a close parallelism between vesicant activity and power to inhibit hexokinase. Moreover, hexokinase has been detected in various tissues, including skin, and the visible development of the skin lesion runs parallel in time with the inhibition of glycolysis. The importance of the inhibition of the phosphokinases, and especially of hexokinase, is thus evident. Dixon, indeed, has suggested that the inhibition of the pyruvate oxidase system, noticed by Peters, may actually involve the inhibition of a phosphokinase since the oxidation of pyruvic acid appears to involve phosphorylation.

Northrop (1942) has shown that the growth of yeast can be inhibited by mustard gas without affecting respiration, glycolysis, proteolysis or invertase activity. The different biological system used may account for this apparent divergence from the phosphokinase theory, though the results do suggest that even more sensitive systems than the hexokinase one may be involved.

The actual chemistry of the reaction between hexokinase and mustard gas is still unknown, and we are still ignorant of the cause of the time lag in vesication. Hexokinase is inhibited at once *in vitro* by mustard gas, but the inhibition of hexokinase in rat skin only occurs after a delay corresponding in time to the appearance of skin changes.

Sensitivity of 'Hot and Sweaty' Skins

It is a well-established fact that the skin is more sensitive to mustard gas in hot climates than in cold. Moreover, even in temperate climates, certain regions of the skin are more sensitive to mustard gas vapour than others; for example, the skin of the scrotum and of the armpits shows vesication much more easily than the skin of the rest of the body. An attempt has been made to discover the factors involved in determining the sensitivity of the skin to mustard gas vapour (Cullumbine, 1943). The experimental results suggest that the moisture on the surface of the skin plays the major part in increasing the sensitivity of 'hot and sweaty skins', although increased temperature, by increasing the solubility of the vesicant and accelerating its 'fixation' in the skin, may aid this.

Treatment of Mustard Gas Intoxication

Many methods of preventing vesication, once contamination was established, were tried with varying degree of success. One drastic but effective method was by the use of certain acids—trichloroacetic, monochloroacetic, and thioglycollic—which were effective for a considerable time after contamination and against many (if not all) vesicants (Cullumbine, 1943). These acids prevent the immediate loosening of the epidermal–dermal junction, thrombosis of the small skin vessels thus limiting the serous effusion also occurring. An intact firm epidermis instead of a vesicle is produced, though this skin may break down later.

Various local methods of treatment of the mustard gas skin lesion have been considered. The therapies have been tested by two means: (*a*) on small standard experimental burns on volunteers (Cullumbine and Sinclair, 1943); (*b*) on actual clinical cases of vesication. The findings indicate that mustard gas burns will heal in a similar manner, though possibly more slowly than thermal burns, and can be treated in the same way as thermal burns. Epidermal regeneration begins about the third day and, when complete, is often hypertrophic with ingrowths and 'nests' of epidermal cells evident in the dermis. If the blister is intact, mere collapse of the blister roof is advantageous, since pain, infection and healing-time would seem to be reduced.

It must not be forgotten, however, that general treatment is just as important in the case of mustard gas burns as with thermal burns. 'Shock', toxæmia and secondary infection must all be guarded against or treated. If the contamination has been severe, general symptoms and signs may be manifest before the skin requires treatment.

The most consistent organic lesions occurring in human cases of mustard gas intoxication are those in the intestinal tract and the bone marrow, indicating that a toxic factor must be transferred from the local site of contamination. Certainly the mustard gas, in some form or other, rapidly enters the blood from the skin (Ball, 1942; Henrique *et al.*, 1942). Lymph does not carry mustard gas at all, since the lymph draining from the contaminated hind-limb of a dog was non-toxic (Courtice, 1944). The skin itself or the œdema fluid, however, do not appear to contain a systemic toxic factor (Cullumbine, 1944). The circulating form of mustard gas is rapidly taken up from the blood by the tissues generally (Young, 1942; Ball, 1942). However, although there is no preferential absorption, some of the tissues, for example, the bone marrow and the intestinal tract, suffer specific damage, others do not (Dixon and Wormall, 1943). There is a suggestion that the toxic factors are formed locally in these specific tissues, since extracts of bone marrow from intoxicated animals will produce bone marrow changes upon injection into normal animals (Cullumbine, 1944). The damaged tissues show an early increase of capillary permeability, so that the local liberation of a capillary permeability factor may play some part in the systemic lesions. Such a factor can be demonstrated in the extracts of intoxicated bone marrow and, unlike normal serum, the serum from intoxicated animals does not inhibit the activity of this factor.

Dixon *at al.* (1943) have shown that the anaerobic glycolysis and the respiration of rabbit bone marrow are inhibited after an intravenous injection of a lethal dose of mustard gas; the action is delayed and exhibits a parallelism, in time, with the histological changes. Hence, Dixon has suggested that inhibition of hexokinase may play an important part in mustard gas systemic poisoning. It may have a part in the pathology of the bone marrow changes, but not in the intestinal changes, since Cori (1943) has shown that, after the intravenous administration of mustard gas, the hexokinase and the phospho-creatine phosphokinase of the intestine are not affected, but the inorganic pyrophosphatase and cholinesterase are inhibited.

In general, the more serious the prognosis from skin contamination the lower the white cell count. Attempts to reverse the bone marrow damage by means of non-specific stimulants have so far failed (Courtice, 1943; Cullumbine, 1943). Certain compounds with high competition factors have shown promise in reducing the mortality of contaminated animals; but the time intervals for effectiveness of these compounds are short. This suggests that, as in the skin, once 'fixation' has occurred in the tissues, the process would seem to be irreversible (Cameron and Rydon, 1944).

The mortality can also be reduced by the simple administration of sodium chloride solutions, by mouth, subcutaneously, or intraperitoneally (Cullumbine, 1944); the administration preferably commencing early and continuing throughout the possible period of mustard gas intoxication. The replacement of electrolyte lost locally and in the intestines and via the saliva, vomitus and diarrhœic stools is apparently an urgent need.

I am indebted to the Chief Scientific Officer, Ministry of Supply, for permission to publish this paper.

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EDWARD LHWYD: GEOLOGIST, BOTANIST AND PHILOLOGIST (1660-1709)

By V. A. EYLES

ACCOUNTS of the lives, work and writings of some of the more prominent naturalists and men of science who flourished during the second half of the seventeenth century and the early years of the eighteenth, among whom may be mentioned Newton, Boyle, Hooke, Ray and Plot, have provided the subject-matter of a number of books published in recent years. A further addition to these studies has now been issued as a result of the labours of the late Dr. R. T. Gunther*. It forms volume 14 in the series "Early Science in Oxford", and has been published posthumously, thanks to the co-operation of Dr. John Johnson, of the Oxford University Press.

Edward Lhwyd, the subject of this volume, was a Welshman. Though his father's name was Lloyd, he preferred to be known as Lhwyd, nearly always signing himself thus. The spelling of his name seems always to have occasioned difficulty, for he has been referred to in one place or another as Llwyd, Lhuyd, Llhuwyd, Floyd, Floid, ffloid and, *latinè*, as Luidus or Luidius.

Lhwyd was very active in his time as a student of botany and of fossils, and he also devoted much attention to philology and archæology; but he has received little mention from historians of science. Yet he was well known to contemporary scholars, among whom he was held in esteem, and with a number of whom he corresponded for many years. The deficiency in our knowledge has now been remedied by Dr. Gunther.

The opening pages of Gunther's work are occupied by a reprint of a short life of Lhwyd compiled by Richard Ellis, and published some years ago by the Honourable Society of Cymmrodorion[1]. Following this biographical account, a selection, totalling 288, from the very considerable number of letters extant that were written by or to Lhwyd has been reproduced. These are arranged in strictly chronological order, but have been divided into groups, representing successive periods in Lhwyd's life, each of which is prefaced by a commentary by Dr. Gunther. Among the correspondents John Ray and Martin Lister figure very largely, but a number of other well-known names occur in the list, including those of John Aubrey, the antiquary; Dr. John Woodward, founder of the Woodwardian chair of geology in Cambridge; Dr. Richard Richardson, the botanist; and Tancred Robinson, botanist and friend of Ray.

Lhwyd, after attending Oswestry Grammar School, went up to Oxford in 1682, being entered at Jesus College, which then, as now, had strong Welsh associations. His means were slender, necessitating his taking up a paid appointment, and about 1684 he became assistant to Dr. Plot, the first keeper of the Ashmolean Museum, with the title "Register of the Chymicall courses of ye Laboratory". He would have preferred an appointment which would have enabled him to travel abroad, so that he could acquire a wider knowledge of the subjects that interested him, but circumstances were against him. For a time, therefore, his movements were confined to journeys into the countryside within easy reach of Oxford. During these trips he searched the fields and quarries thoroughly for botanical and geological specimens, even training children and labourers to assist in the work; and he was sometimes accompanied by visiting scholars.

During these early years in Oxford, Lhwyd pursued his studies in a variety of subjects with great application, and gained the friendship of a number of the more influential members of the University. As a result, when, in 1690, Plot resigned from the keepership of the Ashmolean Museum, Lhwyd was appointed to succeed him. This position, though still not a well-paid one, gave him more freedom, and his first excursion outside the Oxford district followed before very long. It resulted from a commission to supply fresh material about Wales for a new edition of Camden's "Britannia", then being prepared under the general editorship of his friend Edmund Gibson, later Bishop of London. Lhwyd agreed to "doe all Wales; & to take a journey speedily quite through it for ten pounds in hand; and twenty copies of y^e Book, when it shall be published". He visited Wales to execute this commission in 1693, and the results of his work appeared in 1695, in the new edition of the "Britannia". Lhwyd's acceptance of this work was not primarily for monetary reward; but in the hope of advancing his own reputation sufficiently to influence patrons who might finance more extensive travelling. In this he met with some success, as will be mentioned below.

Meantime, by 1695, Lhwyd's collection of fossils had grown so large that he decided to prepare a catalogue for publication. He petitioned the University to undertake this for him, but without success; and it was only with the assistance of Sir Hans Sloane, and other friends, including Sir Isaac Newton, who each agreed to subscribe for ten copies, that the catalogue ultimately appeared, in 1699, in a small edition of 120. It bore the title "Lithophylacii Britannici Ichnographia", and included brief descriptions of nearly eighteen hundred fossils, with a note of the locality in which each had been found. Many were illustrated by such carefully drawn figures that it is still possible to identify them accurately (some of Lhwyd's fossils are illustrated in Gunther's work). The book is noteworthy as the first systematic catalogue of British fossils. Of the small number printed, it is stated that thirty were sent abroad, and the work is now very rare. A reprint, with some additional matter, was published by the Clarendon Press in 1760.

Returning again to 1695, Lhwyd's contribution to Camden's "Britannia" was evidently favourably received. Gibson, in writing to a correspondent in Oxford, remarked: "When I tell you, that the whole business of Wales was committed to the care of Mr. Edward Llwhyd . . . no one ought to dispute the justness and accuracy of the Observations". Shortly after the publication of the book, some gentlemen of Glamorgan invited Lhwyd to undertake the preparation of a natural history of Wales. Nothing suited the impecunious Lhwyd better, provided he could raise sufficient funds to cover his travelling expenses. He therefore caused to be printed a pamphlet outlining an ambitious "Design of a British Dictionary, Historical and Geographical; with an Essay Entituled, Archaeologia Britannica: and a Natural

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* "Early Science in Oxford." By R. T. Gunther. Vol. 14: Life and Letters of Edward Lhwyd. Pp. xv+576+14 plates. (Oxford: A. E. Gunther and Dr. Mavis Gunther, c/o University Press, 1945.) 42s.

History of Wales", in which he solicited annual money payments from parties who were interested in the project. His appeal, which was circulated in London and in Wales, attained its object. He therefore prepared a further circular, a questionnaire, in which he sought information from local residents about the geography, antiquities and natural history of the districts he proposed to visit. This also was widely distributed by the somewhat uncertain methods then available, not only in England and Wales, but eventually in Scotland and Ireland as well.

Having thus prepared the ground, early in 1697 Lhwyd set out on his travels. These were to last several years, though latterly the subscriptions promised by his patrons were not all forthcoming. First Wales was revisited, and then he crossed to Ireland, where he was welcomed by members of the Dublin Philosophical Society, and also visited the Giant's Causeway. From Ireland he went on to Scotland, where he met the distinguished Edinburgh naturalist and physician, Sir Robert Sibbald. In a letter written from Bathgate, near Linlithgow, in December 1699, he informed Martin Lister that he had "sped well enough in ye Highlands as to some materials for ye Archaelogia Britannica". Ireland was revisited, and then he returned to Wales. Towards the end of 1700 we find him in Cornwall and, early in 1701, he set out for Brittany. His journeys up to now had not been without minor mishaps, but in France he met with a somewhat more serious misadventure. He was arrested as a spy, and spent eighteen days in confinement in a fortress in Brest. Conditions on the Continent were such that he had to cut short his visit to France, and he returned to Oxford in March 1701.

The remainder of his life was spent in and around Oxford, interrupted only by a short visit to Cambridge to examine certain manuscripts. Apart from his duties as keeper of the Ashmolean, a post that he retained until his death in 1709, his time was spent in digesting and preparing for publication the vast stores of information accumulated during his travels, and sent to him by correspondents. Unfortunately, little of this reached the stage of publication. In 1707, however, volume 1 of "Archaeologia Britannica" was printed in Oxford. It bore the sub-title "Glossography", and was devoted to comparative Celtic philology. Among those competent to appreciate it, it seems to have been looked on as a work of great merit, and Ellis quotes the statement of one authority, that Lhwyd "was in many respects the greatest Celtic philologist the world has ever seen"[2]. Unfortunately, this somewhat abstruse work did not please the Welsh squires who had subscribed towards paying for a natural history of Wales.

Owing to Lhwyd's preoccupation with philological and archæological matters during his last years, his botanical and geological studies seem to have been suspended, though his letters show that he had not entirely lost interest in these subjects. In fact, there is little doubt that it was his intention to publish a natural history of Wales, had he survived, and this, no doubt, would have contained much of interest to botanists and geologists. Unfortunately, after his death, his manuscripts were dispersed, falling into private hands, and, later, by accident, many were burnt.

Thus, apart from the "Lithophylacii", Lhwyd published comparatively little that is of interest to naturalists. He contributed a number of papers to the *Philosophical Transactions of the Royal Society*, including some of botanical and geological interest. His contribution to Camden's "Britannia" included botanical notes; and his friend Ray made use of botanical material supplied to him by Lhwyd. He also supplied Martin Lister with shells that were figured by the latter in his publications on conchology. In passing, it may be mentioned that he contributed material used by Ray in his "Collection of English Words not Commonly Used".

Gunther stresses especially Lhwyd's geological work. Certainly in his earlier years the study of fossils occupied much of his time, and his "Lithophylacii" is a work of very considerable interest and merit. It is remarkable for the accuracy of its illustrations, and for the fact that the fossils figured are carefully localized. Lhwyd is also remembered, among palæontologists especially, as the first to figure a specimen of the extinct order of trilobites. Yet to claim, as Gunther does, that Lhwyd is to be regarded as the father of British palæontology is, perhaps, to allow enthusiasm to outstrip judgment. His views on the origin of fossils were not so sound as those of his contemporary, Robert Hooke, for example. A lengthy exposition of these views is contained in a letter to Ray which has been reproduced by Gunther (No. 200). In this he refers to the work of Steno; but he does not seem to have profited much from the enlightened views of the latter.

The fact that Lhwyd's genius and energies were dissipated in the study of so many branches of learning possibly accounts for his failure to attain lasting fame in any one branch of natural history, and his influence on the thought of his contemporaries may perhaps have been of more importance than his publications. At all events, he occupies a definite niche in the scientific life of the period, no account of which would be complete without something more than a passing mention of his activities. The gap in our knowledge has now been filled by Dr. Gunther, who has collected into one volume most, if not quite all, the information about Lhwyd's work and career that has survived. The sources from which he has drawn this information are scattered and in many cases not easily accessible, and in producing this most readable book there is no question but that he has performed a most useful service, which does full justice to the memory of a neglected naturalist. It should also prove a useful tool for serious students of the history of science. With this in mind, it is as well to point out that one or two sources of information appear to have been overlooked by Gunther. He makes no reference to an interesting though short memoir on Lhwyd published in 1777[3], nor to three letters to Lhwyd, of Scottish interest, that have been published among the early letters of Robert Wodrow[4]. It is clear, though it is not specifically stated, that not all the Lhwyd correspondence known to Dr. Gunther has been reproduced. It may also be mentioned that the Catalogue of Published Works of Edward Lhwyd (Appendix A) is incomplete, and inaccurate in one or two particulars. Attention has been directed to these faults to put the reader on his guard, but they detract little from the merits of this interesting book.

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[1] *Trans. Hon. Soc. Cymmrodorion*, 1 (1906–7).

[2] *Trans. Hon. Soc. Cymmrodorion*, 51 (1906–7).

[3] Owen, N., "Memoirs of the Life of Edward Lhwyd, M.A., &c.", in "British Remains" (London, 1777).

[4] *Pub. Scot. Hist. Soc.*, iii, 24, 148, 187 and 263 (Edinburgh, 1937).

OBITUARIES

Mr. A. B. Jackson

Mr. Albert Bruce Jackson, who for many years has been an authority on the identification of hardy trees and shrubs, died on January 14 at his home, in the village of Kew Gardens, Surrey, after a short illness. He was nearly seventy-one years of age, having been born at Newbury on February 14, 1876.

On leaving school at the age of sixteen, Jackson began work as a journalist; but it did not appeal to him and he studied botany in his spare time, paying particular attention to the British flora. Some four or five years later his work on British botany attracted the attention of the director of the Royal Botanic Gardens, Kew, who offered him a post as temporary technical assistant in the Herbarium, where he would have an opportunity of furthering his botanical studies. Soon after, Mr. H. J. Elwes and Dr. A. Henry, when preparing their great work, "The Trees of Great Britain and Ireland", wanted an assistant who could look up botanical references and go about the country collecting information about rare and remarkable trees, and Jackson was given the post. It proved to be a very useful appointment, for not only did it enable him to lay the foundation for his future work upon trees and shrubs, but also, as Elwes and Henry had been given facilities for carrying out their work at Kew, Jackson was able to maintain his connexion.

On the recommendation of Mr. Elwes, Jackson undertook in 1910 to prepare a catalogue of the trees and shrubs in the gardens at Syon House, and that was the forerunner of what became a specialized part of his spare-time work. Later, he catalogued the trees and shrubs at Yattenden Court, Albury Park, Westonbirt, Borde Hill, and so late as last year, Dawyck.

In 1910, the director of the Royal Botanic Gardens recommended Jackson for an assistant's post in the Imperial Institute, which he retained until 1932; since when, part of his time has been occupied with specialized work in the Department of Botany in the British Museum. In addition to his other activities he found time to coach a number of people in the identification of trees and shrubs, including the Duchess of Northumberland at Albury Park, and the late Duchess of Bedford at Woburn. It was at the suggestion of the Duchess of Bedford that the collection of trees and shrubs at Woburn was placed under his charge, and he visited the estate periodically for many years. During later years he has advised on the care of the trees for the authorities at Stowe School.

Although I had known Jackson from the date of his entrance into Kew, it was not until 1920 that we came into close contact. I had for several years been collecting material for a book on the Coniferæ, and had got a good start, when a mutual friend told me that Jackson had a similar book in view. I therefore suggested collaboration, and after discussion we agreed that he should undertake the descriptions of hardy species and prepare keys to genera and species; I, on my part, undertaking the descriptions of all other species and supplying cultural and economic information. However, he was working hard at the Westonbirt Catalogue at the time, and in the end undertook the four genera, *Abies*, *Cupressus*, *Juniperus* and *Picea* with the whole of the keys. Through his friendship with Miss Lister he was able to arrange with her to make and supply, free of cost, the many life-size drawings of Conifers which are such a distinct feature of the book. He was very keen on making keys to genera and species, and had often been asked to produce a small book giving keys to the Coniferæ with a few details of identification of the kinds commonly grown in gardens. That book was published in 1946. Among his other activities, Jackson was a member of the Scientific Committee of the Royal Horticultural Society.

W. Dallimore

Mr. William Barnicot, M.B.E.

Mr. William Barnicot, who had been secretary of the Rothamsted Experimental Station since January 1, 1920, died suddenly on December 30. He was born on February 10, 1872, at Shepley, near Huddersfield, and was educated at Marlborough, where he took a prominent part in athletics. Before going to Rothamsted he managed the family business of woollen manufacture, and during the First World War he was commissioned in the R.N.V.R.

Mr. Barnicot's twenty-seven years service as secretary of Rothamsted covered a period of remarkable expansion in agricultural research. The experience of the War of 1914–18 led the Government to devote considerable sums to the development of agricultural science, and both in buildings and in staff Rothamsted shared fully in the increase. Throughout this period of expansion a great deal of work necessarily fell on Mr. Barnicot, which he did with his customary unflurried efficiency. His labours were recognized in 1934 by the award of the M.B.E. In the disturbed conditions of the Second World War, the celebration of the Rothamsted centenary in 1943, although necessarily on a restricted scale, involved much more arduous preparation, in which Mr. Barnicot took a prominent share.

After two brief but serious illnesses in 1941 and 1942, Mr. Barnicot might have retired, but at the special request of the Ministry of Agriculture he agreed to continue until 1947. His loss will be severely felt not only by his colleagues but also by a large number of agricultural scientists throughout the world who have worked at or visited Rothamsted, and with whom he formed many friendships.

We regret to announce the following deaths:

Sir John Flett, K.B.E., F.R.S., director of the Geological Survey of Great Britain and the Museum of Practical Geology during 1920–35, on January 26, aged seventy-seven years.

Prof. W. L. Jepson, emeritus professor of botany in the University of California, on November 7, aged seventy-nine.

Prof. H. P. Lewis, professor of geology in the University College of Wales, Aberystwyth.

Dr. C. T. Madigan, lecturer in geology in the University of Adelaide and well known for his journeys of exploration in Central Australia, on January 14, aged fifty-seven.

Prof. Karl Mannheim, professor of education in the University of London, on January 9.

Hr. J. W. Sandström, director until 1939 of the Stockholm Meteorological and Hydrographic Institute, aged seventy-two.

NEWS and VIEWS

Genetics at Edinburgh: Prof. C. H. Waddington

DR. CONRAD HAL WADDINGTON, formerly of the Department of Zoology, University of Cambridge, has been appointed to the chair of animal genetics in the University of Edinburgh as from January 1, 1947. This chair has been vacant since the end of 1944 when Prof. F. A. E. Crew, its former and first occupant, was transferred to the chair of public health and social medicine. Simultaneously with this announcement comes the intimation that a headquarters of the National Animal Breeding Research Organisation, a creation of the Agricultural Research Council, is being set up in Edinburgh, and that the Genetics Laboratory of this Organisation, which has been occupying temporary accommodation at Hendon, will be transferred to Edinburgh and accommodated in the Institute of Animal Genetics, where it will work alongside the University staff. Prof. Waddington will retain his position as chief geneticist in this Organisation.

Prof. Waddington is a man of many parts. He took his degree at Cambridge in geology; but soon he was displaying his peculiar aptitude as an experimental zoologist by adapting the standard tissue culture technique to the purposes of a very complete investigation of the formation of the embryo. He was successful in showing that the parts of the developing avian and mammalian embryos determine one another's growth just as they were known to do in amphibians. In joint work he studied the chemical nature of the evocator of neural differentiation and the substances which can replace it. For this work he received from the Royal Academy of Belgium the first award of the Albert Brachet Prize given annually for the best published work on embryology. He became a lecturer in zoology at Cambridge in 1932, holding this appointment until 1945 and taking the degree of Sc.D. in 1938. As an illustration of his versatility, it is to be recorded that after taking his degree he held the Arnold Gerstenberg studentship at Cambridge, which is for the encouragement of philosophy among natural scientists. Prof. Waddington later turned to the study of the normal metamorphosis of *Drosophila melanogaster* and the effects on development of many mutant genes, determining in this way and in considerable detail the part played by normal genes in controlling development. During the war years he served with the Coastal Command R.A.F. as scientific adviser to the Commander-in-Chief.

Prof. Waddington's task at Edinburgh will be twofold. On one hand he will be responsible for the conduct of the research basic to the scientific breeding of farm livestock, that is, for the essential 'objective fundamental' research. On the other, he will lead a University department with all its normal functions; that department will produce geneticists for service either in the National Animal Breeding Research Organisation or elsewhere, and in its research on genetics will be unfettered by any restrictions of application. These changes will mean that the opportunities for genetic research in Edinburgh, both fundamental and applied, will be greatly expanded, and this, taken in conjunction with developments projected under the new Research Organisation in other parts of Great Britain, should ensure the full application of the science of genetics to animal breeding.

Atomic Energy Act: Exemption Order

SECTION 11 of the Atomic Energy Act limits the disclosure of information in the field of atomic energy, and the wording of this 'secrecy clause' is such as to include many types of scientific apparatus, under the heading of "plant", and many types of scientific experiments as "production of atomic energy". In the Parliamentary debate, the Minister of Supply had announced his intention of using his powers of exemption under the Act to make an Order which would release from the prohibition the tools of the nuclear physicist and, so far as possible, their results. This Order has now been made (Statutory Rules and Orders, 1947, No. 100, H.M. Stationery Office, 1*d*.). Broadly speaking, it exempts from secrecy any apparatus for the investigation of nuclear reactions, except where the reaction is fission of an element of atomic number greater than 89 and results in a positive energy balance. It also exempts detecting apparatus (such as counters), accelerators (such as cyclotrons) and apparatus for generating charged or uncharged particles (including gamma-rays) by means of nuclear reactions, except by means of chain reactions from fission. The wording of the Order refers to the purpose for which the apparatus is to be operated, and presumably if any such apparatus is designed to be used for producing atomic power, or a weapon, disclosure of the details would remain prohibited except by permission of the Minister. This Exemption Order refers, of course, only to the prohibitions of the Atomic Energy Act, and does not affect the position as regards information obtained from official sources, which remains subject to the Official Secrets Act.

Atomic Energy—Destruction or Construction?

AN instructive series of exhibits has been brought together by the *Daily Express* at the Dorland Hall, Lower Regent Street, London, to demonstrate some of the facts and potentialities of the controlled release of nuclear energy. The exhibition will remain open during February (weekdays, 10.30 a.m.–7 p.m.; Sundays, 2–7 p.m.; admission, 1*s*.). The first corridor illustrates by models and diagrams the structure of the atom, with particular reference to uranium. Then come models of an alchemist's laboratory and the Cambridge High Tension Laboratory, suggesting the change of technique employed in the sciences, leading to a model of the uranium pile and photographs of American plant built for making fissionable material. A considerable section of the exhibition is devoted to the effects of the first three bombs, centring around a large model of Hiroshima, on which the affected areas are demonstrated, and including photographs and also specimens of material affected by the 'flash'. On the constructive side, a model and diagrams are shown suggesting how atomic piles can be used for the production of power, and some of the uses of artificial radioactive elements are suggested. In the cinema which concludes the tour of the exhibition, selected films are shown of the explosions of the two atomic bombs at Bikini, and portions of a captured Japanese film illustrating the effect of the flash on human beings. It is difficult to say which will produce the more lasting impression: the demonstration of the means of releasing nuclear energy and its peace-time potentialities, or the terrible effects of the atomic bomb. The latter emphasize the desperate need for international co-operation and understanding in this field. Since most of the material exhibited has come from official sources, one may well ask why the Government itself could not have arranged such an exhibition.

Clay Minerals Group of the Mineralogical Society

THE Mineralogical Society of Great Britain and Ireland has recently approved the formation of a Clay Minerals Group. The study of these minerals not only constitutes a separate branch of mineralogy, but also is of interest to scientific workers in a large variety of departments of pure and applied research. It was felt by the organisers that a Group of this sort would serve an important function in bringing together these workers and allowing them to exchange ideas based on their common interest in clay minerals. For this purpose provision was made for the holding of regular meetings at which accounts could be given of research in progress, and informal discussions could take place. The first meeting of the Group was held on January 24, and invitations to attend it were sent not only to the nucleus of interested persons in the Mineralogical Society itself, but also to a large number of workers in industrial, pure and applied research likely to be interested. The response was most gratifying, and the meeting was held in the rooms of the Geological Society, Burlington House, and was attended by about eighty people. An introductory address was given by Prof. J. D. Bernal. The following speakers gave accounts of their work: Dr. Mackenzie and Mr. Walker (Macaulay Institute for Soil Research, Aberdeen); Prof. C. H. Edelman (Landbouwhoogeschool, Wageningen); Dr. J. White (University of Sheffield); Mr. K. E. Clare (Road Research Laboratory, Harmondsworth); Prof. Nils Hast (Stockholms Högskola); Dr. Barbara Emödi (Fullers Earth Union, Ltd., Redhill); Drs. A. L. Roberts and G. W. Brindley (University of Leeds); Mlle. Caillère (Museum d'Histoire Naturelle, Paris; S. Hénin (Centre de Recherches Agronomiques, Versailles); Dr. R. K. Schofield (Rothamsted Experimental Station, Harpenden); J. Méring and Mlle. Longuet (Laboratoire Central des Services Chimiques, Paris). In addition, accounts were given of the work in progress at the University of Granada (Spain), and of the work of the Comité Belge pour l'Étude des Argiles. A letter of greeting was received from the latter organisation; also a telegram from Academicians Belyankin and Polynov and other workers at the Dokuchaev Soil Institute, Moscow, which was read at the meeting.

The scientific meetings were followed by a business meeting of the Group members and foreign visitors, at which the functions of the Group, and its relations with similar organisations abroad, were considered. Dr. G. W. Brindley (University of Leeds) was elected president of the Group, and Dr. D. M. C. MacEwan, Rothamsted Experimental Station, Harpenden, Herts, was elected secretary. Promises of support were given by scientific workers from Portugal, Spain and Sweden. M. Hénin gave a promise of collaboration on behalf of the analogous French group, which has recently been constituted (this group differs from the British group, however, in having been set up under Government auspices). Work in Holland in this field was also described. The number of visitors from abroad who were able to attend this one-day meeting was particularly gratifying, and their contributions were very valuable. A reception in honour of the foreign visitors was provided in the evening by the British Council, and they were entertained the following day at Rothamsted Experimental Station.

Halifax House, Oxford

ON January 21, the Chancellor of the University of Oxford, Lord Halifax, formally opened the new Graduate Centre, named in his honour Halifax House, which has successfully been running as a club for senior members of the University since August last. This Graduate Centre was formerly an Anglican convent, standing in two acres of land in Woodstock Road, just north of the Radcliffe Infirmary, and not more than five minutes walk from the main block of science laboratories in the Parks. It is proving a good and timely purchase by the University. The University Grants Committee has helped in financing it. The interior has been skilfully adapted for club use by Mr. J. H. Worthington. Its main purpose is to serve as a club for senior members of the University, especially for those who have, as yet, no college affiliation, for graduates from overseas, for professors from abroad on their sabbatical leaves, for Civil servants from the British Empire back in Oxford for refresher courses and for Colonial and forestry probationers and their like. Halifax House, it is hoped, is but the beginning of a series of clubs in Oxford catering for the needs of senior members which cannot be met by the colleges. It provides, at present, eighteen bed-sitting-rooms for resident members, and two large common rooms and a large garden for non-residents. All meals but breakfast may be had there, and the subscription is only £1 a year.

For several years now the University has had on its conscience the social needs of many of its teachers who tend, at least at first, to be neglected by the colleges. Graduates of other universities appointed to University as opposed to College posts below a professorship, especially in medicine, some sciences and modern languages, may easily find themselves neglected by the colleges and so 'out of things' socially. A large and important modern 'university' now exists in Oxford side by side with the older university with its colleges and great social amenities, and the latter have not done all they could to hold out a friendly, social hand to the former. In the School of Engineering, for example, several of the demonstrators and lecturers have had to wait years before a college noticed their social existence. In the thirty years since the chair was founded, only one teacher below the rank of professor has been made fellow of a college. Halifax House, and similar centres for senior members in Oxford, are bound to play a useful part in bringing together graduates and teachers of many kinds in a social and friendly way who, hitherto, have met little outside working hours.

Production of Oil from Coal in Germany

DR. A. PARKER, director of fuel research, Department of Scientific and Industrial Research, speaking on "Oil from Coal in Germany" at the Fuel Luncheon Club on January 23, stated that Germany developed before the War two synthetic processes, hydrogenation and the Fischer – Tropsch process for the production of petroleum from coal, and many large plants were constructed. At the time of maximum production during the early months of 1944, these two processes together provided oil at a rate of nearly four million tons a year. As a by-product from the manufacture of gas and coke from coal, another one million tons were obtained. The quantity obtained from home-produced natural petroleum was only about two million tons. Natural petroleum gave most of the lubricating oil used, but hydrogenation processes provided almost the whole of the high-grade aviation spirit. The synthetic processes were much more costly than natural petroleum, but with Germany's policy of self-sufficiency cost was not of first importance. It has been estimated that with present-day prices of labour, coal and other materials, the cost of obtaining oil from coal in Great Britain by the processes as developed and operated in Germany would be at least two shillings a gallon, as compared with only about sixpence for imported petroleum, excluding import duties. Research should be continued, however, as there are prospects of improving the methods of obtaining oil from coal, and in certain parts of the British Commonwealth there are cheaper supplies of coal than in Great Britain, as well as reserves of brown coal and lignite. Dr. Parker stated that bombing attacks between May and September 1944 caused a reduction in German production of synthetic oil from a rate of nearly four million tons a year to only about 300,000 tons. During the following months, with a reduction in bombing and determined efforts in Germany to repair damage, production again rose to a rate of one million tons a year in November 1944, after which it again fell to 150,000 tons a year at the end of February 1945. It is certain that this systematic destruction of German oil plants was one of the main factors in hastening the defeat of Germany.

Proposed International Exhibition in 1951

The proposal that an International Exhibition should be held in London in 1951, with other matters relating to exhibitions, was referred by the Secretary for Overseas Trade to a representative Committee (the Ramsden Committee), which, in December 1945, recommended that an international exhibition should be held in London in 1951 or as soon as possible afterwards, and that it should be sited in Central London. The Government accepted the suggestion, but there have been difficulties in finding a site, accommodating visitors, etc. The Royal Society of Arts, which as the Society of Arts took the initiative in promoting the International Exhibition held in Hyde Park in 1851, has joined in advocating the holding of another and far greater Exhibition in 1951 to mark the centenary. The Society has accordingly called a conference for February 6, to give fuller consideration to this question and to discuss in particular: (1) whether an International Exhibition on a large scale should be held in London in the near future; (2) if so, whether Hyde Park should be the site; (3) whether every effort should be made to hold it in 1951, the centenary year of the first International Exhibition. Should the conference approve the general proposal, a formal approach would then be made to the London local authorities and to the Government.

Journal of Research of the National Bureau of Standards

With the July issue, which began the thirty-seventh semi-annual volume, the *Journal of Research of the National Bureau of Standards*, a monthly periodical published by the U.S. Department of Commerce and devoted to pure and applied science, appeared in a new typographical style and size. A larger size of page now brings the *Journal* into line with many other American scientific and technical magazines, such as the publications of the American Physical Society, and with that recently adopted for the Bureau's *Technical News Bulletin*. Other improvements in the general format are a light blue cover, a separate 'contents' page, double reading columns, two-point spaces between the lines of text and tabular matter, and modern type for display heads. These changes make the printed page much easier to read. As in former issues, the individual articles are still printed as separate units, and reprints are made available for purchase as 'Research Papers' from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., shortly after their appearance in the monthly issue of the *Journal*. In this respect it may be of interest to readers to know that H.M. Stationery Office has recently announced that arrangements have been made for that Office to act as agents for U.S. Government publications, and that orders should be sent to the London Sales Office, York House, Kingsway, W.C.2.

The Research Papers, Nos. 1723–29 inclusive, which appear in the July issue, deal with radio-proximity-fuse design for bombs, rockets and mortars which were mainly developed during the Second World War; laboratory distilling columns for the analysis and purification of hydrocarbons; nickel plating on steel by chemical reduction; the temperature coefficients of proving rings used in the calibration of test machines applying forces to engineering materials and structures; the mutarotation and ring structure of mannuronic lactone; the heats of formation and combustion of certain CH_2 groups; and a description and analysis of the spectrum of uranium between 2900 and 11000 A.

Intrinsic Safety of Electrical Apparatus

The use of electrical appliances in coal mines needs to be safeguarded against the risk that they may be the means of igniting firedamp (or coal dust) and thus starting an explosion. Two methods are commonly employed. One is to provide a suitable enclosure from which flame cannot be ejected. The other method is to make the apparatus and related electrical circuits 'intrinsically safe', which means that any sparking which may occur when the circuit is broken at any point is incapable of causing ignition. One aspect of the latter method is discussed in a report, Paper No. 104, published recently by the Safety in Mines Research Board. It gives the relationship which has been found between the inductance in a circuit when the circuit is rapidly broken between a pointed platinum electrode and a wire and the minimum current capable of igniting firedamp. The effects of two methods of increasing the minimum igniting current have been measured. These are the introduction into the circuit of a shunting resistance or condenser. They can be of considerable value when the inductance is high and the current correspondingly low, as in apparatus such as bells, telephones, signalling and shot-firing systems, but become almost valueless when the working current exceeds about one ampere, or in the case of condenser shunts when a slow break of the circuit can occur. The results reported in this paper will be used at the Safety in Mines Testing Station in the examination of mining electrical apparatus submitted by the makers for approval.

"Faraday's Encyclopædia of Hydrocarbon Compounds"

THIS work and the first replacement-addition for Vol. 1 have already been reviewed in *Nature* (April 21, 1945, p. 467; Dec. 22, 1945, p. 744); the second replacement-addition (C_1–C_5) and one for (C_6 and C_7) are now to hand (Manchester: Chemindex, Ltd. 25*s.* and 19*s.* 6*d.* respectively). These follow much the same lines as the original and complete the subject-matter of the Encyclopædia to January 1, 1946. Certain definite improvements making for easier reference have been introduced, as, for example, the recasting of the list of journals so that abbreviations may be more easily traced; more comprehensive treatment of physical properties and the marking of methods of preparation which may be of value in the laboratory will also increase the utility of the work. As before, the labour of changing the sheets and adding the new ones is simple. The author is to be heartily congratulated in being so close to the 'literature front'. Volume C_8 is being printed, and volumes C_9 and C_{10} are promised shortly; new replacement-additions will not be issued until 1948, when it is hoped that all existing volumes will be completed to January 1, 1948.

University of London Appointments

The following appointments have been announced:

Dr. J. J. C. Buckley, to the William Julien Courtauld chair of helminthology tenable at the London School of Hygiene and Tropical Medicine, as from October 1, 1946. He was appointed demonstrator in helminthology at the School in 1927. In 1931 he was awarded a Wandsworth Scholarship and was engaged on research work abroad until 1938, when he became a lecturer at the School. In 1940 he was sent to investigate human onchocerciasis in Kenya, and in 1944 he carried out a helminthological survey in Northern Rhodesia.

Dr. D. W. Smithers, to the University chair of radiotherapy tenable at the Royal Cancer Hospital as from October 1, 1946.

Mr. G. A. Barnard, to the University readership in mathematics tenable at the Imperial College of Science and Technology as from October 1, 1946. During 1940–42 he worked as a research physicist with the Plessey Co., Ilford, and afterwards he went to the Department of the Controller of Physical Research and Signals Development of the Ministry of Supply. Since 1944 he has been a lecturer in the Department of Mathematics at the Imperial College.

The title of professor emeritus of morbid anatomy in the University has been conferred on Prof. H. M. Turnbull, who held the chair of morbid anatomy at the London Hospital Medical College from February 1919 until his retirement in September 1946. The title of reader in anatomy in the University has been conferred on Dr. R. W. Haines, in respect of the post held by him at St. Thomas's Hospital Medical School. The title of reader in palæontology in the University has been conferred on Dr. Alan Wood, in respect of the post held by him at the Imperial College of Science and Technology.

Colonial Office Appointments

THE following appointments in the Colonial Services have recently been made: G. S. Keeping, to be agricultural officer, Malaya; P. H. Nye, to be specialist agricultural chemist, Gold Coast; D. A. Harkin, to be geologist, Tanganyika; Captain P. C. Bindon, to be surveyor, Uganda; D. G. Glassford, to be surveyor, Sierra Leone; G. Corbett (tobacco officer, Mauritius), to be superintendent of agriculture, Cyprus; G. C. Stevenson (geneticist, Department of Agriculture, Mauritius), to be sugar agronomist and plant breeder, British Guiana.

The Night Sky in February

FULL moon occurs on February 5d. 15h. 50m. U.T., and new moon on February 21d. 02h. 00m. The following conjunctions with the moon take place: Feb. 4d. 20h., Saturn 4° S.; Feb. 13d. 04h., Jupiter 0·02° S.; Feb. 16d. 23h., Venus 5° N.; Feb. 20d. 02h., Mars 4° N.; Feb. 22d. 09h., Mercury 7° N. Mercury rises at 8h. 15m., 8h., and 7h. at the beginning, middle and end of the month, respectively, and attains its greatest easterly elongation on Feb. 21. The stellar magnitude of the planet varies between $-1\cdot1$ and $-0\cdot4$ during the month. Venus is conspicuous as a morning star, rising at 4h. 43m., 4h. 56m., and 5h. 02m. at the beginning, middle and end of the month, respectively, the stellar magnitude varying between -4 and $-3\cdot8$ during February. Mars is too close to the sun to be observed. Jupiter, in the constellation of Libra, rises at 2h. 26m., 1h. 41m. and 0h. 52m. at the beginning, middle and end of the month, respectively, its stellar magnitude being about $-1\cdot6$. Saturn, in the constellation of Cancer, is visible throughout the greater portion of the night, setting a little before the sun at the beginning of the month. The stellar magnitude of Saturn is about 0·2 in February. Only one occultation of stars brighter than magnitude 6 takes place in February: Feb. 1d. 00h. 08·3m., 227 B.Taur. (*D*). The latitude of Greenwich is assumed, and *D* refers to disappearance.

Announcements

PRINCESS ELIZABETH has been elected an honorary member of the Institution of Civil Engineers. Her Royal Highness thus becomes the first lady honorary member. Ladies have been considered eligible for election to corporate membership under the charters in view of the provisions of the Sex Disqualification (Removal) Act, 1919, and the first lady member was elected in 1927.

PROF. T. H. HAVELOCK, lately professor of mathematics at King's College, Newcastle-on-Tyne, in the University of Durham, and W. D. Lambert, chief of the Section of Gravity and Astronomy of the U.S. Coast and Geodetic Survey, have been elected *Correspondants* for the Section of Geography and Navigation of the Paris Academy of Sciences.

PROF. A. V. HILL, Foulerton research professor of the Royal Society, Sir Jasper Ridley, a director of Coutts and Co. and of the National Provincial Bank, and Mr. G. M. Young, a member of the Standing Commission on Museums and Galleries, have been elected trustees of the British Museum.

THE Tilden Lecture of the Chemical Society will be delivered by Dr. A. E. Alexander on "The Application of Surface Chemistry to Colloidal Problems" on February 6 at 7.30 p.m.

IN connexion with the announcement of the award of the Charles Vernon Boys Prize of the Physical Society in *Nature* of January 4, p. 21, we have been asked to point out that the word 'Skiatron' is a trademark registered in the name of Scophony, Ltd., to describe dark trace tubes.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Discovery of Molecular Asymmetry

PASTEUR's two lectures on molecular asymmetry (Paris, 1860[1]) are justly regarded as a supreme example of the characteristic lucidity of the French mind and language. Organic chemists point with pride to the fact that scarcely a word of this classic needs to be altered at the present day.

There is, however, one slight error contained in a speculation over-generalizing the phenomenon which we now call internal compensation, and which Pasteur was the first to encounter in the case of mesotartaric acid. To be more precise, it seems that Pasteur related *dl*-malic acid to mesotartaric acid rather than to racemic acid. This misconception was cleared up by the work of Le Bel and van t'Hoff in 1876 and is of little historical importance. Pasteur also spoke of twisted and spiral molecules and of untwisting them (racemization), but only, in his own words, as a "rough metaphor".

These passages are used by Prof. G. F. Gause[2] in justification of the remarkable pronouncement that "Pasteur did not distinguish sharply the disymmetry of individual molecules from the asymmetry of their aggregates in the sense given above". As the excellent monograph, dated 1941 but only just available in Britain, in which this surprising statement occurs, will be widely read, it is perhaps worth while to place on record an individual opinion that Pasteur did indeed make this distinction, and that he made it in the exact sense in which it is understood at the present time. As the point is so well appreciated by the great majority of chemists and physicists, it would be useless to labour it. Let any doubter read the "Lectures on Molecular Asymmetry" for himself. These lectures are built on the foundation of the conceptions of molecular asymmetry and of the mirror-image forms of molecules, and a clear contrast with such a case as that of a quartz crystal is emphasized. Two citations may be given from the English translation.

"We know, on the one hand, that the molecular structures of the two tartaric acids are asymmetric, and on the other, that they are rigorously the same, with the sole difference of showing asymmetry in opposite senses. Are the atoms of the right acid grouped on the spirals of a dextrogyrate helix, or placed at the summits of an irregular tetrahedron, or disposed according to some particular asymmetric grouping or other? We cannot answer these questions. But it cannot be a subject of doubt that there exists an arrangement of the atoms in an asymmetric order, having a non-superposable image."

"Quartz! you will say at once. We saw in the last Lecture that quartz possesses the two characteristics of asymmetry—hemihedry in form, observed by Haüy, and the rotative phenomenon discovered by Arago! Nevertheless, molecular asymmetry is entirely absent in quartz. To understand this, let us take a further step in the knowledge of the phenomena with which we are dealing. We shall find in it, besides, the explanation of the analogies and differences already pointed out between quartz and natural organic products.

"Permit me to illustrate roughly, although with essential accuracy, the structure of quartz and of the natural organic products. Imagine a spiral stair whose steps are cubes, or any other objects with superposable images. Destroy the stair and the asymmetry will have vanished. The asymmetry of the stair was simply the result of the mode of arrangement of the component steps. Such is quartz. The crystal of quartz is the stair complete. It is hemihedral. It acts on polarized light in virtue of this. But let the crystal be dissolved, fused, or have its physical structure destroyed in any way whatever; its asymmetry is suppressed and with it all action on polarised light, as it would be, for example, with a solution of alum, a liquid formed of molecules of cubic structure distributed without order.

"Imagine, on the other hand, the same spiral stair to be constructed with irregular tetrahedra for steps. Destroy the stair and the asymmetry will still exist, since it is a question of a collection of tetrahedra. They may occupy any positions whatsoever, yet each of them will none the less have an asymmetry of its own. Such are the organic substances in which all the molecules have an asymmetry of their own, betraying itself in the form of the crystal. When the crystal is destroyed by solution, there results a liquid active towards polarised light, because it is formed of molecules, without arrangement, it is true, but each having an asymmetry in the same sense, if not of the same intensity in all directions."

Prof. Gause has identified one of Pasteur's metaphors with the theory that they illustrated.

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Jan. 6.

[1] "Leçons de Chimie professées en 1860" (Chemical Society of Paris, 1861, Alembic Club Reprint No. 14).

[2] "Optical Activity and Living Matter", *Biodynamica* (1941), cf. p. 10, footnote 3.

Mixed Crystal Formation in High Polymers

AN interpolymer of ethylene and vinyl alcohol (prepared by co-polymerization of vinyl acetate and ethylene followed by hydrolysis[1]) has been found to give a crystalline X-ray diffraction pattern different from those of either polythene or polyvinyl alcohol. The fibre repeat distance is 2·5 A., corresponding to a single hydrocarbon chain zigzag. This fact alone indicates that there is no regular succession of the different monomer units along the chain molecules, because such a regular arrangement would have a fibre repeat period of at least twice the observed value. The succession of monomer units is thus apparently random, so that this is an example of the crystallization of high-polymer molecules of geometrically irregular structure. Such a crystal can be appropriately regarded as a mixed crystal. We have here yet another analogy between the crystallography of polymeric substances and that of monomeric chemical compounds.

We have studied this and several other examples of isomorphous replacement in crystals of long-chain molecules; this work will be described and discussed in detail elsewhere.

It is of particular interest to try to discover what differences of size and shape can be tolerated in the replaceable units. Thus a single hydrogen atom on a carbon chain may be replaced by a fluorine or a hydroxyl group, but apparently not by a chlorine or a methyl group; a pair of hydrogen atoms may be replaced by an oxygen atom. It is difficult to discuss the degree of tolerance in quantitative terms, but it would appear that the limits are much wider than for ionic or metallic crystals.

These facts appear to have certain implications. Since a hydroxyl group may replace a hydrogen without destroying the crystallinity in the interpolymer already mentioned, it follows that in polyvinyl alcohol itself the hydroxyl groups might be randomly placed in the alternative space positions on either side of the plane of the carbon chain. It has formerly been assumed that the fibre repeat-distance of 2·5 A. proves that the hydroxyl groups in polyvinyl alcohol are all on the same side of the plane of the carbon chain, in any event within the length of molecule in any one crystallite; and a complete crystal structure based on molecules having this regular configuration has been put forward[2]. The assumption now seems to be not necessarily correct. It has been urged by one of us[3] (for other reasons) that the crystal structure of polyvinyl alcohol should be reconsidered, and we now suggest that alternative structures based on molecules having hydroxyl groups indiscriminately in left- and right-hand positions should be considered.

The second implication affects the theory of crystallinity of chemically homogeneous polymers. We have long considered that those polymers which do not crystallize (for example, polyvinyl acetate and polystyrene) fail to do so because the substituent groups occur indiscriminately in left- and right-hand positions, so that the molecules, though chemically regular, are geometrically irregular; whereas other polymers such as polythene, polyvinylidene chloride and many polyamides and polyesters are crystalline because they have either no substituents or two identical substituents on any one chain carbon atom; these molecules, therefore, are geometrically as well as chemically regular. At the Chemical Society discussion on high polymers held last April, it was pointed out that the properties of polyvinyl alcohol and polyvinyl acetate are difficult to reconcile with this theory. Polyvinyl alcohol and polyvinyl acetate are chemically interconvertible and, therefore, might be supposed to have their substituent groups in precisely corresponding positions; yet polyvinyl alcohol crystallizes well, whereas polyvinyl acetate has never been crystallized. The regularity of polyvinyl alcohol has hitherto been unquestioned, and, on the assumption that polyvinyl acetate must likewise be regular, other explanations of non-crystallization of the latter have been sought. Our present evidence suggests that the argument should be reversed. Thus, we postulate that the acetate, because it is non-crystalline, is irregular; if we assume that the alcohol is likewise irregular, the fact that it crystallizes, which would formerly have seemed a difficulty, is to be attributed to the comparative smallness of the hydroxyl group, which can replace hydrogen in a polymer crystal lattice. Thus, we submit that the above-mentioned theory is essentially sound in correlating crystallinity with geometrical regularity of molecules and non-crystallinity with geometrical irregularity; but that when substituent groups are similar in shape and size, molecules which are chemically irregular may be sufficiently nearly geometrically regular to crystallize.

The third implication is that, even in crystals of chemically regular polymers the molecules of which *can* be geometrically regular, different configurations of monomer units obtainable by rotation around single bonds might occur, provided that the energy contents and the effective external shapes of the alternative configurations are similar. This might possibly occur in rubber; a regular structure which accounts well for the X-ray diffraction pattern has been proposed[4]; but there are two types of configuration, both having about the right fibre repeat-distance, readily interconvertible by rotation around single bonds, and not very different in effective overall shape, and it is not impossible that the two types might be present in the same crystal. Whether a structure comprising comparable proportions of two different molecular configurations is compatible with the X-ray evidence is a matter which can be decided by calculations of the relative intensities of the X-ray reflexions.

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Nov. 21.

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[1] Perrin, M. W., Fawcett, E. W., Paton, J. G., Williams, E. G., and I.C.I., Ltd., B.P. 497,643 Ex. 14; and du Pont de Nemours, Inc.; B.P. 582,093.

[2] Mooney, *J. Amer. Chem. Soc.*, 63, 2828 (1941).

[3] Chapter by Bunn in "Advances in Colloid Science", 2, 121 (Interscience Publishers, 1946).

[4] Bunn, *Proc. Roy. Soc.*, A, 180, 40 (1942).

Rate of Crystal Growth in Glass

THE shape of the curve relating the rate of crystal growth to temperature of undercooling is familiar as a hump-backed curve. The shape of the low-temperature portion is usually ascribed to viscosity, and that at higher temperatures either to surface tension barriers hindering nucleus formation, or to a rather arbitrary undercooling factor based on the geometry of the phase diagram[1]. The former is inadmissible where the growth of crystals already in existence is being considered, and the latter gives a very poor agreement with the experimental data, due, no doubt, to the arbitrary nature of the assumptions involved.

Examination of the problem in the following manner leads directly to a curve of the right type, though it has proved difficult to substantiate the portion immediately below the liquidus in the example studied.

If a plane glass-crystal boundary is considered, the ions in the glass require a vibrational energy E_1 to enable them to become mobile, while those in the crystal require E_2. Of the glassy ions at the crystal boundary, those which are mobile and have energy less than E_2 will condense, whereas those in the crystal with greater energy will melt, so that the rate of crystal growth (R) will be proportional to

$$\frac{1}{kT}\int_{E_1}^{E_2} \exp - E/kT \,.\, dE - \frac{r}{kT}\int_{E_2}^{\infty} \exp - E/kT \,.\, dE, \quad (1)$$

where r is the ratio of the surface densities of crystal and glass.

Thus,

$$R = A \exp - E_1/kT \left\{1 - (r+1) \exp \frac{E_1 - E_2}{kT}\right\}. \quad (2)$$

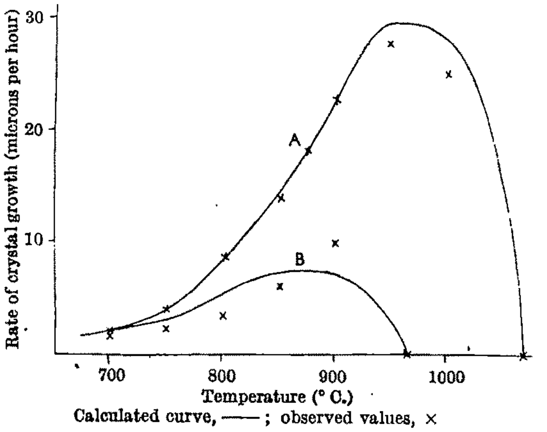

Fig. 1

The curve *A* of Fig. 1 shows the measured and (assuming $r = 1$) calculated crystal growth-rates for cristobalite separating from Pyrex brand glass with liquidus at 1,064° C.

In Fig. 2, log viscosity is plotted against the reciprocal of the absolute temperature (*C*), together with the logarithm of the rate of devitrification (*D*) for points on the left-hand slope of curve *A* (Fig. 1). It is at once seen that the power of this latter exponential (given by the slope of the curve in Fig. 2) is only about a quarter of the value of the corresponding constant for viscosity.

Presumably in the present case the major requirement for crystal growth is the removal of the boron and sodium ions from the Si-O lattice, thereby giving the necessary freedom to collapse to crystal form without any major positional change. The preponderance of cristobalite, considered unstable at this temperature, is then readily explained.

While no information is available for the boron ions, the temperature variation of the mobility of the sodium ions may be inferred from the electrical conductivity measurements. Values for the latter extrapolated from lower temperatures are also shown in Fig. 2 (curve *E*). When the composition of the glass (approximately 80 per cent SiO_2; 12 per cent B_2O_3; 4·6 per cent NaO) is borne in mind, it will be seen that the slope of the low-temperature portion of the curve is in reasonable accord with the above views.

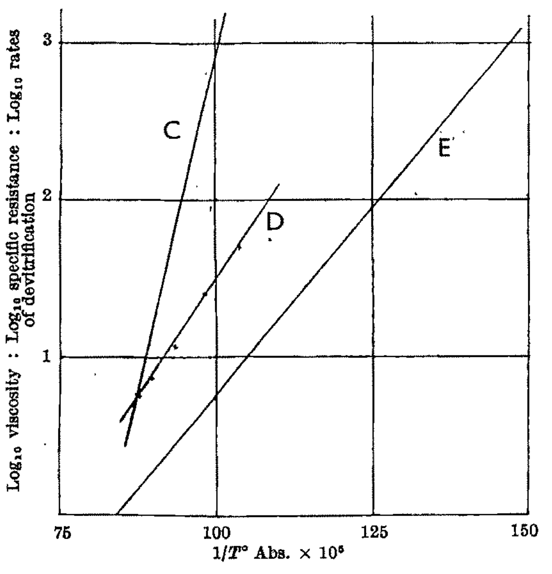

Fig. 2

For other glasses of the same class precipitating cristobalite, the constants *A* and E_2 in the above formula may be considered to remain substantially unchanged; so that, using their determined values and the liquidus temperature for the new glass, one can anticipate the form of the variation of the devitrification-rate with temperature. Thus the curve *B* (Fig. 1) was determined for a glass containing 21·5 per cent B_2O_3, and the crosses are the observed rates.

S. M. Cox
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Dec. 13.

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[1] Preston, E., *J. Soc. Glass Tech.*, **24**, No. 104 (Aug. 1940).

Ultra-violet Absorption Spectrum of Anhydrous Nitric Acid

Recently, Ingold and co-workers have presented evidence of the existence of the nitronium ion (NO_2^+) in solutions of nitric acid in concentrated sulphuric acid[1,2]. We wish to report some observations on the ultra-violet absorption spectrum and electrical conductance of the system water/nitric acid/nitrogen pentoxide which are of relevant interest.

The absorption maximum of the nitrate ion at 3020 A., present in the spectrum of dilute aqueous solutions of nitric acid, diminishes in intensity as the acid concentration is increased. Above about 60 per cent acid concentration, this maximum is not seen, and there appears instead a maximum near 2600 A.[3,4,5,6]. A maximum at this position was noted also by von Halban and Eisenbrand[5] in the spectrum of a solution of nitric acid in anhydrous ether, and attributed by these authors to the undissociated $HO-NO_2$ molecule. Hantzsch[6] failed to confirm this, and reported that in anhydrous ether nitric acid shows no absorption maximum.

Our measurements have extended over a concentration range from 80 per cent nitric acid – 20 per cent water to 76 per cent nitric acid – 24 per cent nitrogen pentoxide. With 20 per cent of water present there is a well-defined maximum at 2650 A. ($E_{\text{max.}}$ 9·9, see Curve *A* of Fig. 1; molecular extinction coefficients are calculated for HNO_3). As the water content is decreased, this band becomes stronger and reaches a maximum intensity of 11·7 with 7 per cent of water present (Curve *B*, Fig. 1). With further diminution in the water content the intensity of the maximum falls to a lowest value for 5 per cent water ($E_{\text{max.}}$ 9·5, Curve *C* of Fig. 1). With approach to the anhydrous acid the extinction at the maximum rises again, but this second increase is accompanied by considerable flattening of the curve. The spectrum of the anhydrous acid is shown in Curve *D* of Fig. 1.

Comparison with the curves for solutions of nitrogen pentoxide in anhydrous nitric acid show no discontinuity in the neighbourhood of the anhydrous acid. Solutions of nitrogen pentoxide in carbon tetrachloride or acetic anhydride exhibit very intense steeply rising absorption at wave-lengths less than 3000 A.

These data indicate that, in aqueous solutions of nitric acid containing between 5 and 20 per cent of water the spectroscopically predominating species is

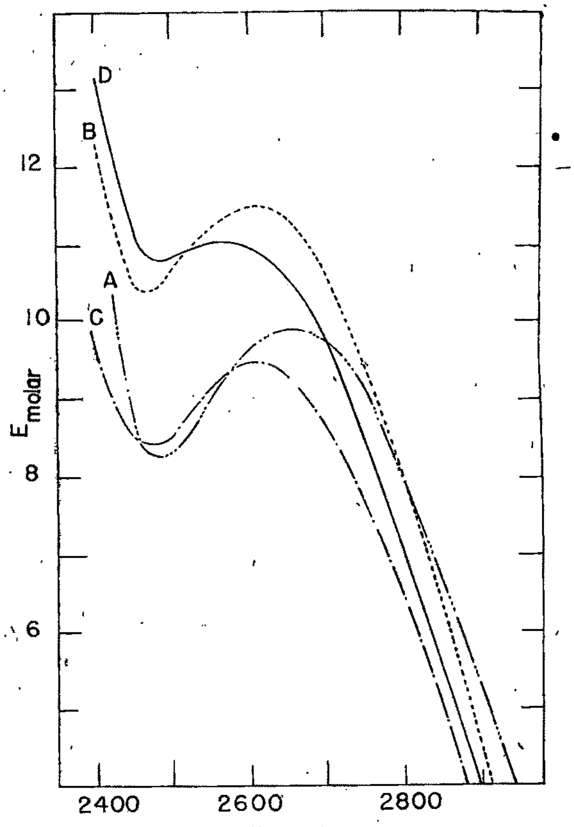


Fig. 1. ULTRA-VIOLET ABSORPTION SPECTRA OF AQUEOUS NITRIC ACID SOLUTIONS. *A*, 20 PER CENT WATER ; *B*, 7 PER CENT WATER ; *C*, 5 PER CENT WATER ; *D*, ANHYDROUS ACID

a molecule or ion designated the '2600A chromogen' which may be the HO–NO_2 molecule. It is in maximal concentration in the presence of 7 per cent of water. When the water content is reduced to less than 5 per cent the spectrum flattens in a manner consistent with the establishment of an equilibrium such as (1) with 'free nitrogen pentoxide' in solution.

$$2\,HNO_3 \rightleftharpoons H_2O + N_2O_5 \quad . \quad . \quad (1)$$

This hypothesis is in accord with the lack of discontinuity noted in passing from the 95 per cent acid to solutions containing excess nitrogen pentoxide (Figs. 1 and 2).

These spectrographic measurements provide no clue as to the condition of the dissolved nitrogen pentoxide, but parallel studies of the electrical conductance of these systems at 25° C. have confirmed the earlier observation of Veley and Manley[7] that the equivalent conductance is minimal for a solution containing about 3 per cent of water and increases as the anhydrous condition is approached. With addition of nitrogen pentoxide to the anhydrous acid the conductance continues to increase, and there is no discontinuity apparent in the neighbourhood of the anhydrous acid.

The sharp increase in conductance with less than 2 per cent water-content is suggestive of the formation of a highly ionized compound and is consistent with the establishment of an equilibrium such as (2).

$$N_2O_5 \rightleftharpoons NO_2{}^+ + NO_3{}^- \quad . \quad . \quad (2)$$

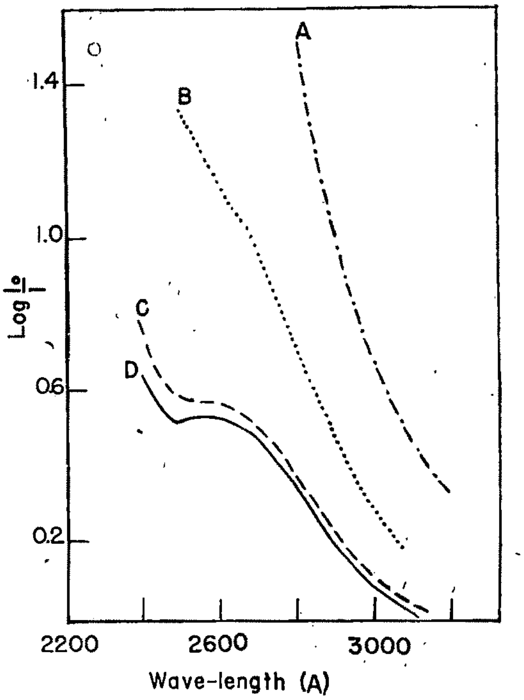
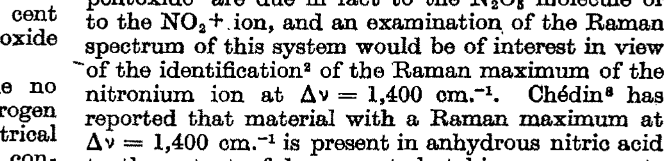


Fig. 2. ULTRA-VIOLET ABSORPTION SPECTRA OF SOLUTIONS OF NITROGEN PENTOXIDE IN ANHYDROUS NITRIC ACID. *A*, 24 PER CENT NITROGEN PENTOXIDE ; *B*, 12 PER CENT NITROGEN PENTOXIDE ; *C*, 3 PER CENT NITROGEN PENTOXIDE ; *D*, ANHYDROUS ACID. (THE OPTICAL DENSITIES HAVE BEEN CORRECTED FOR CHANGE IN THE SPECIFIC GRAVITY OF THE SOLUTIONS)

Both the spectrographic and the conductance measurements over the complete concentration range are consistent with a system of equilibria as shown in (3).



(3)

It is uncertain whether the changes in the absorption spectrum attributed to 'free nitrogen pentoxide' are due in fact to the N_2O_5 molecule or to the $NO_2{}^+$ ion, and an examination of the Raman spectrum of this system would be of interest in view of the identification[2] of the Raman maximum of the nitronium ion at $\Delta\nu = 1,400$ cm.$^{-1}$. Chédin[8] has reported that material with a Raman maximum at $\Delta\nu = 1,400$ cm.$^{-1}$ is present in anhydrous nitric acid to the extent of 1 per cent, but his measurements on aqueous solutions of nitric acid were carried out at relatively large intervals of concentration change.

The diminution in the intensity of the 2600 A. maximum between 7 and 5 per cent water content remains unexplained. An association such as is shown in (3) has been proposed by Dalmon and Freyman[9] to account for changes in the near infrared spectrum of the nitric acid–water system over the same concentration range.

The discrepancy between the observations of von Halban and Eisenbrand[5], and Hantzsch[6], on the spectra of solutions of nitric acid in anhydrous ether, can be understood if Hantzsch's acid contained appreciable amounts of dissolved nitrogen pentoxide.

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Nov. 29.

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[1] Gillespie, Graham, Hughes, Ingold and Peeling, *Nature*, **158**, 480 (1946).

[2] Ingold, Millen and Poole, *Nature*, **158**, 481 (1946).

[3] Hartley, *J. Chem. Soc.*, **83**, 221 (1903).

[4] Schaefer, *Z. anorg. Chem.*, **98**, 77 (1916).

[5] von Halban and Eisenbrand, *Z. phys. Chem.*, **132**, 433 (1928).

[6] Hantzsch, *Z. phys. Chem.*, A, **147**, 161 (1930).

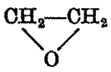
[7] Veley and Manley, *J. Chem. Soc.*, **33**, 1015 (1903); see also Berl and Saenger, *Monats. für Chemie*, **53-54**, 1036 (1929).

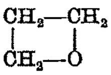
[8] Chédin, *Ann. Chim.*, **8**, 243 (1937).

[9] Dalmon and Freyman, *C.R. Acad. Sci. Paris*, **211**, 472 (1940).

Structures of Ethylene Oxide and Cyclopropane

THE formula of ethylene oxide is commonly portrayed as (I), the instability of the compound being ascribed to the existence of strain tending to open the ring. This explanation can scarcely be accepted, for, if it were true, the compound (II), with less angular strain, should be more stable—which it is not. Zimakov[1] has recently directed attention to this point and to the discrepancy between the structure (I) and the observed properties of ethylene oxide. He points out that the latter (for example, polymerization, addition reactions) strongly suggest a resemblance of structure to ethylene, and proposes to replace (I) by a resonance hybrid of (I), (III) and (IV).


(I)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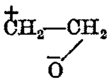
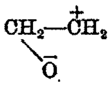
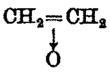

(III)


(IV)

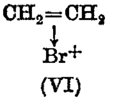

(V)

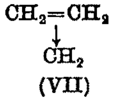
The concept of the 'co-ordinate link' type of bond is well accepted in chemistry, and is indeed necessitated by the existence of such compounds as $BF_3.NH_3$. It has hitherto been supposed that the 'donated' electrons must be initially non-bonding, but in molecular orbital theory there is nothing to warrant this limitation. In a recent paper[2] we have generalized the concept to include also donation by bonding electrons and have given many illustrations of problems that then receive a simple explanation. Dewar[3] has independently put forward similar ideas, and must be regarded as the first to develop the new theory. It is true that donation by lone pair electrons is more commonly observed, but this is because such electrons are usually more weakly bound than bonding electrons. It is the study of ionization potentials that provides the knowledge that enables one to say which electrons in a molecule are most likely to be donated. For donation by bonding electrons to occur, it is essential that these electrons should have especially low ionization potentials. π-Electrons in olefines fulfil this condition, though there appears to be no need strictly to limit such donation to π-electrons.

The π-electrons of ethylene lie in an orbital of ionization potential 10·45 V.[4]: the lone pair electrons of ammonia lie in an orbital of ionization potential 10·8 V.[4]. We therefore expect donation of the π-electrons of ethylene, just as donation of the lone pair electrons of ammonia occurs. Just as NH_3 forms NH_4^+, $(C{=}C) \rightarrow H^+$ is expected and plays an important part in acid-catalysed olefine polymerization[2]. $BF_3.C_2H_4$ is expected, just as $BF_3.NH_3$ is known. The formula of ethylene oxide may be portrayed as (V), and an analogy may be drawn between it and the amine oxides. (V) is closely analogous to the complex (VI) that probably plays an important part in the bromination of olefines[2]. The formula means that the two electrons of the original π-bond in ethylene now bind the three nuclei C, C and O. This need cause no surprise when the modern knowledge of conjugated molecules and non-localized bonds is recalled. Each carbon atom is in the trigonal state, forming three planar, hybridized sp^2, σ-bonds at 120°. This is in contrast to (I), where $\angle$ HCH should be close to 109°. The fourth valency of each carbon atom is a pure $2p_z$ orbital of axis at 90° to the plane of the molecule. These $2p_z$ orbitals of the carbon atoms overlap with each other and with the $2p_z$ atomic orbital of an oxygen atom lying alongside with the correct orientation. We therefore construct a non-localized molecular orbital, described in the LCAO approximation as

$$a\,\psi_A(C : 2p_z) + a\,\psi_B\,(C : 2p_z) + b\,\psi(O : 2p_z).$$

The trigonal configuration of the two carbon atoms and the existence of π-electrons account for the striking parallel between the properties of ethylene oxide and those of ethylene. The formula (V) is simpler than the cumbrous resonance description in terms of (I), (III) and (IV), though it may amount to much the same thing in ultimate thought content.


(VI)


(VII)

We have already stressed[2] the importance of the idea of donation of π-electrons to the understanding of the reactions of the methylene molecule. We regard cyclopropane, like ethylene oxide, as having a perturbed ethylene structure (VII). Two very strong pieces of evidence for this view are that (1) substances in which a cyclopropane group is adjacent to a double bond exhibit just those spectroscopic properties which are characteristic of conjugated compounds; (2) the dipole moment of cyclopropyl chloride is 0·3 *D* lower than the value for isopropyl chloride[5]: this is easily understood on analogy with phenyl chloride, but very difficult to understand[5] on the conventional formula for cyclopropane.

Further discussion of these points will be given elsewhere.

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Cambridge.

Dec. 7.

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[1] Zimakov, *Acta Phys. Chim. U.S.S.R.*, **31**, 401 (1946).

[2] Walsh, *J. Chem. Soc.*, in the press.

[3] Dewar, *J. Chem. Soc.*, 406, 777 (1946).

[4] Sugden, Walsh and Price, *Nature*, **148**, 372 (1941).

[5] Rogers and Roberts, *J. Amer. Chem. Soc.*, **68**, 843 (1946).

Reactions of Organic Halides in Solution

We are sorry to have again to contradict Dr. Evans, but he continues to misrepresent us[1]. He does so now by quoting a limited passage from a paper by one of us[2], and then adding, as though it were a paraphrase, a statement of his own that does not, in fact, reproduce the meaning. The passage is dealing with the relative rates of nucleophilic halogen-substitution in R-Hal, where R = Me, Et, *n*-Pr, *i*-Bu, *neo*Pentyl, and, as quoted, reads : "The rate relationships for the first four members are fairly normal for the bimolecular mechanism, the rate of which is decreased by electron-accession to the reaction centre, but the introduction of the last β-methyl substituent has obviously introduced an effect which is far larger than that to be expected on the basis of its capacity for the release of electrons. . . . This effect is believed to be of steric origin." Dr. Evans continues : "This indicates that steric hindrance was considered to be unimportant in the bimolecular S_N2 reactions of RX when R is methyl or ethyl". On the contrary, it "indicates" what it states, namely, that the total structural effect on rate when R = *neo*pentyl is in fact far greater than in the other cases, that Hughes could not see why the polar effect of methyl should take such a sudden jump as the last methyl is introduced, and that he could see a reason why its steric effect might do so.

Concerning Dr. Evans's historical comment that, although Hughes first estimated[2] the steric compressions involved in S_N2 reactions of RX for R = Me, Et, he did not then (1941) "specifically" consider *i*-Pr and *t*-Bu, it may be remarked that, in the approximation to which we have hitherto worked, the specific consideration which was then lacking consisted only of multiplying by 2 and 3 in the respective cases, that is, duplicating and triplicating the ethyl compressions.

We thought we had previously made it clear that we were aware of the steric effect of the α-methyl group in the bimolecular reactions of α-methylallyl chloride, but regarded Dr. Evans's method of analysis as unsound[3].

As to unimolecular reactions, Dr. Evans's method of treatment appears to be similar to that which led Baughan, Evans and Polanyi[4] to the conclusion, which we believe to be incorrect, that the known inactivity of *neo*pentyl halides in certain substitutions is a property of the ionization mechanism. Hughes established a contrary conclusion[5] in 1941.

Note added in proof. The Editors of *Nature* have allowed us to see Dr. Evans's comment. His new quotation, like the previous one, is divorced from its context : in both, the standard of comparison was the very special group, neopentyl. It should be impossible to construe such comparisons between groups as comparisons of polar and steric effects in the same (ordinary) group, since, in the paragraph now partly quoted, calculations are reported which show appreciable steric compressions in ordinary groups.

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C. K. Ingold

University College, London.

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[1] Evans, A. G., *Nature*, 158, 586 (1946) ; cf. *ibid.*, 157, 438 (1946) ; cf. also Hughes and Ingold, *ibid.*, 158, 94 (1946).

[2] Hughes, *Trans. Farad. Soc.*, 37, 621 (1941).

[3] Hughes and Ingold, ref. 1.

[4] *Trans. Farad. Soc.*, 37, 377 (1941).

[5] Ref. 2. Cf. Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 173 (1946).

I submit that the interpretation given above by Profs. Ingold and Hughes for the passage which I quoted[1] is not made clear in the original text[2]. What I see expressed in the paper regarding the bimolecular reactions of R-Hal for the Me, Et, *n*-Pr, *i*-Bu, neopentyl series can be illustrated once more by Prof. Hughes's statement that "It is therefore concluded that in addition to the retarding influence of methyl substitution, which operates throughout the series, and may be attributed essentially to the inductive effect, there is a superposed effect, which may in principle enter in all stages of β-substitution, but which assumes real importance only in the case of the neopentyl halide. This effect is believed to be of steric origin[2]."

Apart from this historical question, I wish to emphasize again that, in my view, the decrease in bimolecular reaction-rate along the Me to *t*-Bu series is due solely to the increase in steric hindrance along this series. This point of view is developed in detail in my forthcoming papers on the subject[3].

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University,
Manchester.

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[1] Evans, A. G., *Nature*, 158, 586 (1946). Cf. Evans, A. G., *ibid.*, 157, 438 (1946). Hughes and Ingold, *ibid.*, 158, 94 (1946).

[2] Hughes, *Trans. Farad. Soc.*, 37, 623 (1941).

[3] Evans, A. G., *Trans. Farad. Soc.*, in the press. "The Reactions of Organic Halides in Solution" (Manchester University Press, 1946).

A Method of Using Marked Phase Boundaries

When iron is oxidized in air, foreign particles on the original surface of the metal will later be found imbedded in the oxide layer. From this observation Fischbeck[1] concluded that iron, not oxygen, migrates through the reaction product. Starting from this fact, we have worked out the following simple method for ascertaining the direction of migration in reactions between solid substances.

On the original phase boundary a mark is made, using a substance which can be seen (at least with a microscope), does neither lessen the contact between the reaction partners nor react with them, does not act on the reaction product and does not change in any way, physically or chemically, during the process. It should, therefore, be observable after the reaction. The migration of matter is then recorded directly from the position of the mark in relation to the starting materials and the reaction product.

The method has been found suitable when studying the systems magnesium oxide/magnesium pyrophosphate[2], lead oxide/lead silicate[3], lead oxide/lead sulphate[4] and zinc oxide/aluminium oxide[5], using platinum for marking ; and the system silver/sulphur[5], using gold.

Robert Jagitsch

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Chalmers Institute of Technology,
Gothenburg.
Dec. 4.

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[1] Fischbeck, K., *Metallwirtsch.*, 14, 733 (1935).

[2] Jagitsch, R., and Perlström, G., *Arkiv Kemi, Min., Geol.*, 22A, No. 5 (1946).

[3] Jagitsch, R., and Bengtson, B., *Arkiv. Kemi, Min., Geol.*, 22A, No. 6 (1946).

[4] Jagitsch, R., and Mattsson, B., unpublished results.

[5] Bengtson, B., and Jagitsch, R., *Arkiv Kemi, Min., Geol.*, in the press.

An Optical-Acoustic Method of Gas Analysis

DR. M. VENGEROV has described a method of gas analysis under this title[1]. As the method has been in practical use in the chemical industry for about ten years, I should like to direct attention to the self-recording infra-red absorption apparatus, called 'Uras', developed by Dr. Luft-Oppau.

The principle of this analyser is the same as that of Dr. Vengerov, but the arrangement is somewhat better. The radiations of two infra-red sources pass into two gilded glass tubes, after being interrupted periodically by a revolving disk with two sectors, and are absorbed finally in a condenser chamber separated into two parts by a thin metal foil. One glass tube contains a standard gas, and through the other streams the gas to be examined. The condenser chamber contains some of the gas under examination. Both the tubes and the condenser chamber are sealed with rock-salt windows, allowing the infra-red rays to pass through. In front of the separating foil in the condenser chamber is an insulated wire gauze arranged to form a kind of condenser microphone.

If the streaming gas contains an unknown component, this will absorb its characteristic radiation out of the infra-red beam. As the condenser chamber contains the same gas, it also will absorb only this characteristic radiation. The effect will be that the part of the condenser chamber beneath the analyser tube is not so much heated as the standard part, and the condenser foil is deflected less in relation to the wire gauze. The condenser microphone is in the grid circuit of a three-stage amplifier tuned to the frequency of the revolving disk.

The arrangement of two separated beams eliminates any effect of changes in the infra-red source, and the filling of the condenser chamber with a special gas guarantees great selective efficiency of the apparatus. If necessary, tubes containing the disturbing gas components can be placed in front of the analyser tubes. These tubes then act as spectral filters and absorb the characteristic radiations of the extraneous gases out of the two beams. By this device the presence of one of these disturbing gases in the gas to be examined causes no effect on the condenser chamber and the condenser itself.

With the 'Uras' the percentage can be recorded of any organic or inorganic gas having absorption bands within the range of the infra-red source, to which the condenser chamber has been adjusted. The sensitiveness is sufficient to record traces of the gas of the order of magnitude of fractions of a thousandth part.

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[1] *Nature*, **158**, 28 (1946).

Experimental Data and 'Sufficient' Accuracy

MR. H. A. HUGHES has pointed out[1] that replication could cease when a required standard of accuracy is attained, and that, from a sample size of n, the estimate, α, of the probable error of its mean ". . . decreases with ascending values of n until the minimum value permitted by the experimental conditions is reached".

Since $\alpha\sqrt{n}$ in general converges in the statistical sense to a finite limit—the probable error of a single observation—clearly α similarly converges to zero. Expressed practically, we may determine a quantity as accurately as we please by adequate replication, provided our measurements are unbiased. The elimination of bias is not, normally, possible. While, therefore, we may reduce α indefinitely, the labour of further replication is unwarranted once the magnitude of α has been reduced to the same order as that of the bias.

A second point: as Mr. Hughes referred to measurements on several systems, I infer he may ultimately have intended to compare them. If this were his sole object in attaining a prescribed accuracy, it would be most economic in replication to apply a sequential test[2]. When sequential tests are impracticable, as in some agricultural and building research when each experiment takes many months, it is possible to plan *a priori* to attain a required certainty of avoiding inadequate replication. It is intended to publish a paper on this in the near future, though it is suspected that reports, probably in the agricultural field, must already exist of prior research on this topic.

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Chief Scientific Advisor's Division,
Ministry of Works.
Dec. 2.

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[1] *Nature*, **158**, 29 (1946).

[2] Wald, A., *Ann. Math. Stat.*, **16** (1945).

Fluid Flow at a Small Hole due to Vibration

I SHOULD like to acknowledge my indebtedness to Prof. Andrade[1] for directing my attention to the work of H. Sell[2]. As a result, I have made a careful examination, by means of strong lateral illumination, of the way in which the smoke particles enter and leave the orifice in the resonator. There is no doubt about the general accuracy of H. Sell's explanation, and this is particularly well demonstrated when the smoke is made to issue in the space between two parallel plates of glass kept apart by a distance piece the thickness of which is approximately that of the diameter of the orifice. The smoke particles can then be seen as bright dots on a dark ground, and their paths easily traced. As well as the back-flow near the surface of the resonator, vortex motion occurs. If, however, the smoke be allowed to issue from a V-shaped mouthpiece formed by sealing two flat pieces of glass between the plates, then, provided the excitation is not too powerful, both the vortex motion and the back-flow cease. There now occurs what appears to the eye as a slow steady motion of the smoke outwards. Examination of the particles with a low-power microscope shows them, however, no longer as dots but as little lines, so that a vibratory motion is superimposed on the general forward motion.

It would appear, therefore, at first sight, that the experiment is now on a more satisfactory basis. When the resonator is constructed of glass, however, vortex motion *inside* the tube in the neighbourhood of the orifice can be seen. Particles within the tube travel normally away from the centre of the orifice, pursue a more or less circular path and return along the base to the orifice once more. Some of these particles, however, move outwards through the orifice, and these constitute the slow steady stream already referred to. The phenomenon is thus of a complicated nature which it is hoped further to investigate.

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Shrivenham,
near Swindon, Wilts.

[1] *Nature*, 159, 132 (1947).

[2] Raleigh, "Sound", 2, 202, describes a somewhat similar phenomenon.

A REPETITION of the demonstration described by Prof. G. D. West in *Nature*[1] showed that it works particularly well with a wide test-tube of length suitable for a 256-fork (even the small laboratory pattern), and having at the closed end a central hole of diameter less than 1 mm., shaped rather like the small aperture of a Helmholtz resonator. By performing the experiment with the aid of a projection lantern, both this effect and a reverse effect not mentioned by Prof. West can readily be shown to a large class. On bringing the tuning fork near the open end of the tube, a puff of smoke is seen to issue from the hole in the closed end, followed by a steady stream of smoke so long as the vibrating tuning fork is held in position. Under the same conditions, a puff of clear fresh air can be seen to enter the tube from outside, followed by a steady stream of fresh air. This is precisely what one would expect, for the closed end of the tube is a pressure antinode, and the so-called 'steady pressure' of sound is in reality a differential effect in which the compressional phase preponderates over the rarefactional phase, the alternating emergence and intake of gas observed at the orifice taking place so rapidly that the eye sees what appears to be a steady stream of gas flowing simultaneously in both directions at the orifice.

The existence of a pressure antinode at the closed end of a resonance tube can also be clearly demonstrated by an arrangement devised by me in 1937 and hitherto unpublished. A glass tube is closed at one end by a clear glass disk about 1 mm. thick. The open end of this tube is attached by 'Plasticene' to the mouth of a loud-speaker (disk type) actuated by an oscillator of variable frequency. The glass disk is found to vibrate perceptibly for certain frequencies of the oscillator, and if a long-focus convex lens is attached by wax peripherally to the glass disk, the resonant states in the tube can be detected by observation in sodium light of the disappearance or enfeeblement of the Newton's rings formed between the lens and disk. With this arrangement, up to eight harmonics of the fundamental frequency of the tube can be detected.

Quite recently another simple device has been found to be very sensitive for the detection of resonance and the existence of an antinode of pressure at the closed end of a cylindrical tube. The closed end is formed by attaching a thin 'Cellophane' sheet to one end of the tube (a 'Cellophane' jam-pot cover serves admirably). The 'Cellophane' is applied wet, and on drying it is quite taut and vibrates vigorously when a suitable tuning fork is held opposite the open end of the tube. If a small quantity of silver sand is dropped on to the 'Cellophane' membrane and the tube is of variable length, the adjustment for resonance can be accurately determined, either by the intensity of the clearly audible patter of the sand on the membrane, or visibly by observation of the movement of the sand. This effect is not to be confused with the corresponding effect in which sand on thin tissue paper attached to a ring is used for detecting antinodes of motion in an organ pipe. The sand on 'Cellophane' detector can be employed effectively in the lantern to demonstrate resonance, when the motion of the sand can be seen and the patter of the sand is audible even in a large lecture room.

In conclusion, it may be mentioned that any of these methods can be used for demonstrating the existence of the 'interference hyperbolæ' around the end of a tuning fork, for the effects described cease as soon as the interference regions fall on the axis of the tube. Either the Newton's rings detector or that using 'Cellophane'-sand can be used with advantage in a laboratory method for the determination of the velocity of sound. The latter detector has been applied successfully for this purpose in this laboratory by my colleague, Dr. E. L. Yates. In the original form of the apparatus, one end of the tube was closed by a loud-speaker element operated by an oscillator at fixed frequency (1,600 cycles per second). The receiver was a hollow cylinder fitting closely in the tube and closed at the near end by a thin copper membrane. The other end of the cylinder was connected to a straight brass tube ending in a rubber listening tube. By noting the position of an indicator on the brass tube for a number of successive resonances, the wave-length of the sound waves could be determined, and hence the velocity. In its modified form, the bottom end of the glass tube is closed by a 'Cellophane'-sand detector and the loud-speaker element (deaf-aid type) is attached to the end of the brass tube. With this arrangement the wave-length can be determined with much greater accuracy, the audible patter of the sand giving sharp response at resonance when the oscillator is operating at minimum output.

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Dec. 24.

[1] *Nature*, 158, 755 (1946).

"The 'Squares' Method for Potential Problems"

THE review by Prof. G. Temple in *Nature* of November 23 is more than generous to my recently published book on "Relaxation Methods", and with my fellow-workers I am grateful for his praise; but a slip in its penultimate paragraph will, I fear, cause misunderstanding if it is not corrected. It is not the relaxation technique but the technique employed, for example, by Shortley and Weller of Ohio State University (who have attributed it to Liebmann, 1918) that "consists in systematically working over the lattice and everywhere replacing the original approximate values of f by the means of its values at the neighbouring corner points".

For brevity this systematic process may be described as 'scanning', since Wiener (among others) in the United States has suggested that the methods of television might be employed to speed up the mean-value computations. It finds no place in the technique of relaxation methods, in which (excepting in the final presentation of results) values of f are *not* recorded at lattice points. Instead, the values recorded are those of 'residuals' defined (in Prof. Temple's notation) by

$$F_P = f_A + f_B + f_C + f_D - 4f_P$$

(or by convenient multiples), and the F's are brought to negligible values ('liquidated') by operations which have nothing in common with 'scanning', and are *not* performed in an iterative sequence.

It was on this account (I suppose) that Prof. H. W. Emmons wrote in the *Quarterly of Applied Mathematics* (October 1944): "In fact, for the computer (as opposed to those who think only about the logic behind the computation methods) the relaxation method has a spirit lacking entirely from the iteration process. The former challenges one's intellect at each step to make the best possible guess, while the latter reduces one to the status of an automatic computing machine." Working throughout in terms of F's, not f's, a computer is *not* compelled to "alter the value of f only at one point at a time"; nor, when he does so, does he make that alteration (usually) what is given by choosing f_P so as to make $F_P = 0$. That rule, as Prof. Temple shows, defines the best way of altering f_P in a single operation; but economy of time demands the minimum number of operations, and from this point of view the rule can usually be bettered. Herein lies the 'challenge' to the computer.

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ECONOMY in space compelled me to focus attention on the most fundamental and elementary process of the 'squares' method, and I could only indicate briefly in the concluding paragraph the higher flights of relaxation technique.

Readers of *Nature* will be grateful for Dr. Southwell's fuller statement of the principles and the spirit of this method.

G. TEMPLE

Effect of Mono- and Divalent Salts on Red Blood Cells

Greville and Lehmann[1] reported that less hæmolysis occurred when human blood was stored with $M/7$ magnesium chloride as an anticoagulant than if isotonic sodium citrate was used. We have investigated this phenomenon for several reasons, one of which was its possible practical bearing on the storage of sheep blood-corpuscles used for the Wassermann reaction in the diagnosis of syphilis.

Fragility Tests. When fragility tests are performed on human blood cells, it can be seen that the osmotic pressure of divalent salts, such as magnesium and calcium chloride and magnesium and sodium sulphate, is about twice that of sodium or potassium chloride (Table 1).

The cells were obtained from citrated blood, washed in the corresponding salt solution and centrifuged. When stored, they were kept at + 4° C. in $M/7$ salt solution in a concentration of 4,000,000 cells per c.mm. For the fragility test, packed cells were suspended to give a concentration of 100,000 cells per c.mm. in 3 ml. of salt solutions diminishing in concentration by 1 per cent of $M/7$ from sample to sample. The highest concentration at which complete hæmolysis was seen was noted after the tubes with the cell suspensions had been allowed to stand for 2 hours at + 4° C.

TABLE 1. HIGHEST SALT CONCENTRATIONS AT WHICH HUMAN RED BLOOD CELLS ARE COMPLETELY HÆMOLYSED. TWO TYPICAL EXPERIMENTS. CONCENTRATIONS OF SALT SOLUTIONS TESTED DIMINISHING BY 1 PER CENT OF $M/7$

Experiment	KCl	NaCl	$MgCl_2$	$CaCl_2$	Na_2SO_4	$MgSO_4$
A	$M/24$	$M/23$	$M/46$	$M/44$	$M/46$	$M/50$
B	$M/26$	$M/25$	$M/58$	$M/50$	$M/48$	$M/46$

Storage of cells in solutions of divalent salts was seen to alter the properties of the cell surface. Compared with $M/7$ sodium chloride, in $M/7$ magnesium or calcium chloride red blood cells became more brittle. They were more easily destroyed by mechanical trauma such as centrifuging, but, at the same time, they became more resistant in hypotonic salt solutions. A similar observation was made by Aub *et al.*[3] when they treated red cells with small quantities of lead. The phenomenon can be observed particularly well in sheep cells, which due to a slight difference in shape from human cells are more easily broken up in hypotonic solutions.

TABLE 2. HIGHEST CONCENTRATIONS OF SODIUM CHLORIDE AT WHICH SHEEP RED BLOOD CELLS ARE COMPLETELY HÆMOLYSED AFTER PREVIOUS STORAGE IN $M/7$ SOLUTIONS OF SODIUM AND MAGNESIUM CHLORIDE

Storage	None	2 days		9 days		16 days	
Salt used for storage	—	NaCl	$MgCl_2$	NaCl	$MgCl_2$	NaCl	$MgCl_2$
Highest NaCl concentration showing complete hæmolysis	$M/14$	$M/13$	$M/17$	$M/13$	$M/28$	$M/14$	$M/39$

It will be seen from Table 2 that the highest concentration of sodium chloride at which sheep red blood cells were completely hæmolysed was the same whether the cells were tested immediately after they were obtained, or whether they had been stored in $M/7$ sodium chloride; storage in $M/7$ magnesium chloride, however, increased the resistance against hypotonic sodium chloride solutions, and the 'toughening' of the cell membrane became more noticeable the longer the storage.

Sensitivity to Hæmolysin. When sheep cells were hæmolysed by antibodies from sensitized rabbits, there was no difference seen when the corpuscles used were stored in $M/7$ sodium or magnesium chloride. The extent of hæmolysis was varied by the addition of various amounts of complement (Wassermann reaction), but the degrees of lysis were the same however long and in whatever isomolecular salt solution the corpuscles had previously been stored (sixty-four experiments).

TABLE 3. AVERAGE MEAN CORPUSCULAR VOLUMES OF TEN SAMPLES OF HUMAN RED BLOOD CELLS SUSPENDED IN VARIOUS SALT SOLUTIONS

Average mean corpuscular volume in plasma: 86 ± 8 cubic μ.

Salt concentration		KCl	NaCl	$MgCl_2$	$CaCl_2$
$M/7$	cubic μ	101 ± 5	105 ± 6	80 ± 15	77 ± 20
$M/14$	cubic μ	124 ± 4	131 ± 6	107 ± 5	104 ± 6

Corpuscular Volume Measurements. Table 3 shows the average of the mean corpuscular volumes found when ten different samples of human red cells were suspended in solutions of potassium and sodium chloride and of magnesium and calcium chloride respectively. Sodium and magnesium sulphate could not be tested as they rendered the cells so brittle that they were destroyed during the centrifuging necessary for the determination of the packed cell volume, and deteriorated even when shaken in the diluting pipette prior to transfer to the counting chamber.

The cells were obtained from plasma oxalated after Wintrobe, washed in the corresponding salt solutions and centrifuged. Packed cells were added to 2 ml. of salt solution to give a final concentration of 2,000,000 cells per c.mm. The suspensions were left for 15 hours at + 4° C., and the mean corpuscular volume was then determined by dividing the packed-cell volume percentage by the cell concentration.

It will be seen in Table 3 that the same size is taken by corpuscles in an *M*/7 solution of mono-valent salt as in half that concentration of divalent salt.

It is noteworthy that the cells increase in volume when transferred from plasma to 'normal saline' (*M*/7 sodium chloride); this is due to the absence of the osmotic pressure of the plasma proteins. This considerable influence of the plasma proteins on the corpuscle-size may underlie the observations of Dyson *et al.*[3] and of Walters *et al.*[4]; the former observed increase of corpuscle-size in blood-loss where tissue water replaced the lost plasma protein, the latter saw shrinking of corpuscles when malnourished individuals received plasma transfusions. Whereas the cells swell in size when transferred from plasma to normal saline, Table 3 shows that they retain their original volume when suspended in *M*/7 solutions of divalent salts. This fact, as well as the 'toughening' influence of divalent ions on the cell membrane described above, may explain the comparative stability of red blood cells observed by Greville and Lehmann[1] when they used *M*/7 magnesium chloride as an anticoagulant.

Our thanks are due to the director of Medical Services in India for permission to publish this communication.

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Nov. 28.

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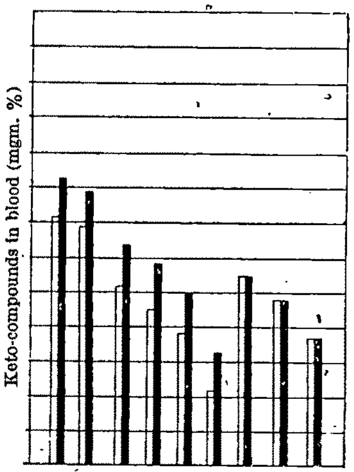
Effect of Proteins on Ketonæmia

The presence of fat is necessary for the increased production of ketone bodies, because they originate from fat. But the part played by the proteins is undecided. Some of the amino-acids are ketoplastic, while others act as antiketoplastic. According to Schaffer[1], fifty-eight per cent of protein is of antiketoplastic effect, while forty-two per cent is ketoplastic; carbohydrates are antiketoplastic in their entirety, while ten per cent of the fats (glycerol) are antiketoplastic, and ninety per cent have a ketone-producing effect. According to Schaffer, ketosis ensues if the amount of ketogene molecules outnumbers that of antiketogenic ones. But Falta[2] could not confirm this attractive explanation. He is of the opinion that proteins exert a specific ketogenic effect, which is not only dependent on the amount of ketoplastic material contained in them; for if he fed much fat and little protein to diabetics, acetonuria was less than if he did the reverse. But this opinion is not shared by such eminent clinicians as Porges and Adelsberg[3] and Noorden[4].



White columns, initial level. Black columns, 6 hr. after administration of fat without protein

The discussion proves that the part played by the proteins in the origin of ketosis is still doubtful, and so the question whether they cause ketosis in ratio to their content of ketoplastic components, or a specific ketoplastic effect of their own beyond that, is still undecided. Further elucidation can only be expected by quantitative investigation, and so far opinion has depended almost exclusively upon clinical observation. Therefore, we undertook the experiments described below.

By the bisulphite-binding method of Clift and Cook[5], we determined the ketone bodies of diabetic and non-diabetic patients in the morning on an empty stomach. Then 150 gm. of oil was administered by stomach-tube (in one case 120 gm. of bacon was ingested) and after six hours the determination was repeated. In another series, fat (120 gm. of bacon) and proteins (in the form of 100 gm. of cheese) were fed.

The table below demonstrates that increase of ketone bodies is insignificant after fat alone; three cases showed no increase at all. This result corresponds to that of Leites, Odinow and Powolowskaja[6], who after ingestion of fat found a ketogenous effect only in some of their cases, while Hoffmann and Anselmino[7] reported an increase in every case. Our results are also in accordance with the findings of Marks and Young[8]. They found that ketonuria was highest in dogs with meta-hypophyseal diabetes when the animals received a diet of raw meat, and lowest with a high-fat diet. Similar results have been obtained by Burn, Lewis and Kelsey[9] with alloxan-diabetic rats.

If fat and protein were administered together, a much more considerable increase followed, with the exception of cases of pregnancy[10], as would have been expected, in proportion to the ketoplastic amino-acid content of the protein. The ketogenic component of proteins being on the average forty-two per cent, after ingestion of fat and protein an increase of one sixth would be expected at the most above fat alone. In our experiments 100 gm. of cheese was ingested besides 120 gm. of fat; the protein content of the cheese being approximately twenty-five per cent. But while after fat the increase amounted on the average to 18·3 per cent, that following combined fat and protein intake averaged 65·2 per cent. If the increase were determined by the ketogenic component exclusively, the ultimate value should be only one sixth larger, that is to say, twenty-one per cent on the average. The difference was statistically significant.

In two cases the blood of the same patients was examined before and after intake of fat, and before and after intake of fat and protein.

INCREASE OF KETONE COMPOUNDS IN BLOOD

	After fat and protein	After fat alone
Diabetes	43 per cent	0 per cent
Cirrhosis of liver	49 per cent	16 per cent

These two cases clearly show the reliability of the conclusion drawn from averages of all cases investigated. In both cases a considerable increase is evident after ingestion of fat and protein; whereas one of them shows no increase at all after fat alone, and the other a slight increase, corresponding to the average of all cases.

Summary. After ingestion of fat and protein, the blood shows a considerably increased content of ketone bodies as compared to fat ingestion alone. This exceeds significantly the amount which could be ascribed to the content of proteins of ketogenic amino-acids, and therefore it may be assumed that proteins exert a specific ketoplastic effect.

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Treatment of Keratitis rosacea with Small Doses of Testosterone

IN the course of some investigations on 'endocrine allergy'[1], it was found that patients with keratitis rosacea (six cases) give a positive intracutaneous test to testosterone. Tests with a series of several other steroid hormones, on the other hand, were negative. Testosterone administered intracutaneously in increasing doses for the purpose of desensitization brought about a striking improvement of the ocular condition in all the patients. In cases in which the keratitis rosacea was associated with facial rosacea, a distinct improvement was also observed in the latter condition.

Although therapeutic results in keratitis rosacea must be interpreted cautiously in view of the occurrence of spontaneous remissions, allergy to testosterone appears to be a cause of this condition in at least a high percentage of cases. A detailed study will be published in the *British Journal of Ophthalmology*.

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Development of *Ornithodorus moubata* on Normal and Thiamin-deficient Rats

De Meillon and Golberg[1] reported that early nymphs of *O. moubata* when fed on thiamin-deficient rats display a retardation of growth as compared with nymphs fed on rats given a full diet. Since that time, the ticks have been reared to maturity and the following results obtained.

DEVELOPMENT OF *O. moubata* ON NORMAL AND THIAMIN-DEFICIENT RATS

Stages of development		Rats fed on	
		Full diet	Thiamin-free diet
I	No. fully fed	20	24
II	*P*	96	100
	T	9·2 ± 0·4	11·6 ± 1·4
III	*P*	100	90
	T	8·6 ± 0·7	14·0 ± 1·2
IV	*P*	100	100
	T	8·8 ± 1·4	12·5 ± 1·7
V	*P*	100	78
	T	14·5 ± 1·0	26·4 ± 12·0
VI	*P*	—	64
	T	—	15·2 ± 0·8
Mean time (in days) to adult stage		41·1	79·7
Number of moults to reach maturity		4	5

P, percentage of fully fed ticks which moulted.
T, mean and standard deviation of time (in days) from feed to moult.

The evidence presented in the table shows that thiamin deficiency in the host affects the development of *O. moubata* by prolonging the time taken between each feed and the subsequent moult, and by inducing an additional moult before maturity is reached. As a result, the ticks on thiamin-deficient rats take almost twice as long to become adults as do ticks fed on normal rats. Unfortunately, all the ticks from the control group of nymphs were females, so that it is not possible to compare egg production in the two groups.

We have now shown that two unrelated blood-sucking arthropods, *Cimex lectularius* and *O. moubata*, are adversely affected by feeding on thiamin-deficient rats. Experiments with other deficiencies are under way.

We wish to thank Miss F. Hardy, Miss V. B. Arvidsson and Mr. J. M. Thorp for technical assistance.

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Johannesburg. Dec. 7.

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Seasonal Variations in Vitamin C Content of Tomatoes Grown in Great Britain

RESULTS obtained in the Ovaltine Research Laboratories in 1942[1] suggested that the vitamin C content of tomatoes grown in Great Britain is affected by the degree of exposure to sunshine during cultivation. It is also related to the size of the fruit, position on the plant, date of collection, etc.; but if these and other disturbing factors are balanced by careful sampling, the average vitamin C content might be expected to vary significantly with sufficiently wide differences in climatic conditions in different seasons.

These suggestions have been supported by experimental results obtained at Long Ashton in 1944[2] and 1945[3]. The average vitamin C content of tomatoes grown out of doors in 1945 was only three quarters of that of tomatoes grown under the same conditions in 1944, sufficient samples being taken to ensure a significant difference. The lower vitamin C content in 1945 was correlated with a smaller number of hours of sunshine during August, September and October. Strange to say, this latter factor made only a slight difference to the vitamin C content of tomatoes grown under glass, which in both years averaged rather less than two thirds of the average outdoor figure in 1944.

TABLE 1. SEASONAL VARIATIONS IN VITAMIN C CONTENT OF ENGLISH TOMATOES

Season	Districts where grown	No. of varieties	No. of samples	Mean vitamin C content (mgm./100 gm.*) Cultivation indoor	outdoor	Hours of sunshine during cultivation†
1942	Elstree	mixed	11	15·4	—	—
	King's Langley	mixed	39	—	16·6	—
1944	Long Ashton	2	130	19·5	—	471
		2	80	—	30·3	
1945	Long Ashton	9	49	17·7	—	347
		13	64	—	22·3	
1946	Elstree	mixed	11	15·8	—	—
	Maidstone	5	117	—	16·0	345

* Of edible portion of fresh fruit.

† Included August, September and October until harvested.

Climatic conditions in 1946 have been even worse than in 1945, and the growth and ripening of tomatoes out of doors have been more difficult than usual. Therefore, we think it of interest to compare in Table 1 average figures for the vitamin C content of tomatoes grown indoors and outdoors this year with the average results previously obtained in these conditions at King's Langley and Long Ashton. Whereas our average indoor figure (though based on only a few samples) does not differ significantly from the indoor averages obtained in previous years, our average outdoor figure is much lower than the Long Ashton outdoor averages in 1944 and 1945, though it agrees well with the outdoor average in 1942. Varietal differences cannot explain more than a small part of this difference, because one of the varieties (Premier) which we have tested this season was also tested at Long Ashton, and the ratio of its average vitamin C content to that of all the five varieties we examined was 1 : 1·3, as compared with 1 : 1 obtained at Long Ashton for all their varieties. Fertilizer treatment also will not satisfactorily explain the difference. We tried a variety of fertilizer mixtures containing known amounts of nitrogen, phosphorus, potassium and calcium, and, while some of these did appear to increase the vitamin C content, the results obtained on different samples showed that climatic conditions were still an important factor. The outdoor tomatoes we examined were grown at Maidstone Technical Institute and were of medium size (that is, 60–120 gm.), care being taken to exclude very small and very large fruit in which the difference in size might affect the vitamin C content. Hence this factor also would not seem to explain the lower average vitamin C content found this season.

In order to study the climatic conditions more closely, the mean hours sunshine daily and the mean monthly maximum and minimum temperatures were determined (Table 2). The latter also includes parallel results and averages for a number of previous years at East Malling, near Maidstone (kindly supplied by the Director of the East Malling Research Station). Although there is much evidence that the vitamin C content is affected by exposure to sunshine, and possibly also by warmer climates, the data do not provide clear-cut proof of this, and it is to be hoped that other workers who have been examining tomatoes this season will also compare the effect of climatic factors. We have confirmed previous findings that the vitamin C content is little altered by ripening indoors off the plant instead of outdoors on the plant.

TABLE 2. SUNSHINE AND TEMPERATURE RECORDS DURING TOMAT CULTIVATION

Season	Districts where grown	Mean hours sunshine daily Aug.	Sept.	Oct.	Mean monthly maximum and minimum temperatures (° F.) Aug.	Sept.	Oct.
1944	Long Ashton	6·9	5·0	3·4	—	—	—
1945	Long Ashton	5·1	3·0	2·1	—	—	—
1946	Maidstone	5·7	3·9	3·0*	53–69	50–63	50–62*
1946	East Malling	5·7	4·2	—	51–68	50–65	45–60†
	East Malling. Mean of last 30-33 years	5·8	4·8	—	52–71	48–66	—
	East Malling. Mean of last 10 years	—	—	—	52–71	48–66	45–60†

* Until final harvest.

† First fortnight.

Our results have been obtained on fruit cultivated, collected and stored with greater precautions to increase and conserve vitamin C than can normally be applied to commercial tomatoes, and the figures given in Table 1 for the average vitamin C content must be appreciably higher than the average vitamin C content of similar tomatoes as purchased by the public. It is, therefore, of interest to notice that the average vitamin C contents quoted in this table are considerably lower than the figures of 7 mgm./oz. and 25 mgm./100 gm. recently published from the Ministry of Food[3] and the Medical Research Council[4] respectively. It would be desirable to know how the official figures were obtained, and what allowance was made for climatic and other factors affecting vitamin C content, before deciding whether they can be used as a fair indication of the vitamin C content of British tomatoes in 1946.

We are indebted to Miss E. Finnegan, Miss H. Williams and Miss J. Wyatt for assistance in preparing the extracts and carrying out the estimations.

Full details of these results will be published elsewhere.

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FUTURE OF THE SOCIAL SCIENCES

A CONFERENCE of social scientists, convened by the Association of Scientific Workers, was held on December 14 at Gas Industry House, London, S.W.1. Mr. J. R. M. Brumwell took the chair, and the chief speakers were Prof. S. Zuckerman, Dr. G. Wagner, Mr. Dennis Chapman and Mr. R. Innes. The chairman recalled the meeting held in October 1945, at which a Joint Sciences Committee had been set up to foster relations between workers in the natural and social fields of science. The Committee had functioned successfully, and, as a direct result of its activities, an increased awareness of the links between natural and social science had spread throughout the Association of Scientific Workers. In August 1946, the functions of the Committee were assumed by the Science Policy Committee of the Association. This step was taken to avoid duplication of effort because the work of the two groups soon began to overlap. The Joint Sciences Committee was provisionally reconstituted as a Social Sciences Committee to concentrate on problems of organisation and development of the social sciences themselves. Social scientists in the Association had become more conscious of their own problems of recruitment and training. It was now proposed to set up a national section of the Association of Scientific Workers representing social scientists throughout the United Kingdom.

The terms of reference of this group were: first, to advise on policy in regard to the social sciences; second, to advise on conditions of work and employment of social scientists; third, to stimulate the recruitment of social scientists into the Association; and fourth, to suggest ways of ensuring adequate representation of social scientists on committees of the Association.

Prof. Zuckerman spoke of the value of scientific discipline in social affairs and in the objective study of human institutions. He quoted with approval some observations made by Mr. Herbert Morrison in his Hobhouse Memorial Lecture, which revealed a sympathetic appreciation of the potentialities of social science. He went on to discuss the Clapham Report and, while admitting that the Report suffered from certain shortcomings, maintained that they were not so serious as some of its critics seemed to suppose. The Clapham Report marked a step forward though, possibly, a short step and not the great stride desired by the critics. It was the first official recognition of the existence of the social field of research. In Prof. Zuckerman's view the chief obstacle to progress in this field lay in the shortage of trained research workers. Hence he stressed the need for establishing a body to determine priorities for pursuing research in the social sciences. In the present state of knowledge such a body could perform a more valuable service than a Social Science Research Council, if such were set up.

Prof. Zuckerman drew a distinction, in the light of his war-time experience, between the tactics and strategy of social operations. Operational research during the War had its roots in the need to solve tactical problems as exemplified in the field of radar. But as the War advanced, the work of operational research stations, in the Army and Navy as well as in the Royal Air Force, began to impinge upon problems of strategy as well. The needs of peace likewise opened up possibilities of a dual tactical and strategical approach. Tactical problems arose, for example, in the fields of traffic, output per worker, management, incentives, selection of personnel, and building processes, all of which required investigation 'on the spot'. He remarked that in connexion with the building programme, research of this type was proceeding apace, and it was possible to control the chief variables. But such problems should be distinguished from the more fundamental strategical problems involving the selection of alternative policies or courses of action. The task of scientific workers was not merely to 'clean-up' problems arising out of a situation not of their own making, but to play a part in creating the social situation. As yet, natural sciences had not become involved in the strategy of social operations; but research which commenced with a tactical aim might acquire a strategic value. Thus Prof. Bernal's studies of air raid effects began with the aim of assessing the protective properties of shelters. They developed into a basis for offensive strategy by providing data on the dislocation of social and industrial life resulting from air attack. In this way, scientific method came to influence the choice of a major line of policy. In peace-time, economists, in particular, had an important strategical part to play, for policy might be directly determined on the basis of the data provided by them. In the epoch of planning into which we were entering, science had an important strategical function to perform.

Research in the social sciences was, in his view, expensive as, for example, in carrying out social surveys. With the present shortage of trained man-power, however, and the organisational difficulties, it was, in fact, difficult to spend large sums of money on research. Housing surveys were now 'limping along' for lack of trained workers to carry them out. There was an urgent need for more social surveys to illumine policy.

An important factor in stimulating the development of the social sciences was the attitude of administrators. It was essential that administrators should acquire an appreciation of the use of scientific method in human affairs. Experience in operational research had taught that a genuine scientific attitude on the part of the investigator mattered more than training in a particular field of science. On occasion, arts graduates without a specific training in science had proved their worth in this field.

The future for the social sciences, he went on to say, must be viewed in the light of the academic background, the number of trained workers available, the adequacy of the methodology, the various fields of application and the opportunities for *ad hoc* tactical and fundamental strategical approaches.

In summing up, Prof. Zuckerman concluded that the outlook for the social sciences was 'very rosy'. Authorities in the field of social action were more ready now to listen to the advice of men of science. Nothing could therefore prevent further expansion.

Mr. R. Innes outlined the organisation of the Association of Scientific Workers. There were seven national sectional committees, including, for example, chemistry and engineering and metallurgy. It was proposed that the terms of reference of the provisional social sciences committee would carry over to a new national committee. Members of the Association in different parts of Great Britain who were active in the field under consideration would be linked together through the national committee, which should be widely representative of interested members.

Mr. Dennis Chapman made a strong plea for the expansion of social research. The position of the social sciences, he said, had been transformed by the publication of the Clapham Report. There were two main fields of activity. First, there was the field of fundamental research. Here, he thought, the position was lamentably backward. Brilliant generalizations of two or three decades ago by Patrick Geddes, the Webbs, Graham Wallas and others had lain dormant for want of initiative, to follow up with research. Over a wide potential range of social problems research was, at present, non-existent. No inquiries were being undertaken on such subjects as human relations in industry and politics, the family, the church and other institutions or on the social process of education. No studies were being made of the social psychology of morale, civil and industrial, or into the medical and nursing services of Britain. No one had yet attempted to study the curious distribution of civic vitality in different cities. The methods employed to-day in social research needed revitalizing. They had not advanced since the days of Charles Booth and Beatrice Webb. Many of the techniques were thirty or forty years old and needed bringing up to date. In the United States the methods of social measurement had made far more rapid progress.

In the applied field, the position was much the same. Little research was being pursued. Yet every administrative action was a social experiment and threw up problems for investigation. Social processes were constantly changing and creating experimental situations. It was untrue to assert that there were no experiments in the social field. On the contrary, social scientists were overwhelmed by the multiplicity of experiments taking place around them.

The situation as regards the status and salaries of social scientists left much to be desired. In the universities, status was good but the salary of the few engaged in the 'sweated trade' of social research was appreciably below that of a teacher with similar qualifications in the same subject. In Government Departments, on the other hand, there was no settled status for social scientists. Many were regarded as administrators or as statisticians; scope for publishing results of official research was also severely restricted. It would be disastrous, he thought, if all financial support for social research went to the universities. Almost every important advance in social research, so he declared, had taken place outside the universities. There was a strong case for setting up a Social Science Research Council.

During the ensuing discussion, a number of important points came to light. In Government Departments, it was said, personnel work failed to be accorded adequate recognition. It was a neglected service to be run by officers of the clerical grade without appropriate training. Another speaker challenged Prof. Zuckerman's assumption that scientific method influenced administrative decisions in sufficient measure; a great deal more 'pre-decision' analysis was needed. In this connexion, he mentioned that the Social Sciences Committee had set up a special group to study the requirements of a scientific public administration.

A third speaker reminded the meeting that it was not the function of the Association to carry out research for which full-time investigators properly financed were required. But the Association could survey a field so as to indicate the kind of research and scientific organisation that were needed. What the Association had attempted to do for fuel and power could be done for the field of social inquiry. The main weakness at the moment was a deficiency in fundamental knowledge of social phenomena. He did not regard as adequate the suggestion in the Clapham Report that provision for social research in the universities should be determined by a sub-committee of the University Grants' Committee. Opportunities should be left open for the talented individual with an inquiring mind. Universities, Government departments and other institutions should not monopolize research. Anyone who had ideas for research and could convince a small authoritative body of their value should be given sufficient financial aid to carry out the necessary inquiries. If such steps were taken the large number of workers with experience in operational or social research would have an opportunity of proving their worth. This speaker also directed attention to the need for studying the effects of advances in the social and economic research upon the development of technique in the physical sciences. We were well aware of the impact of science on society. What was now needed was a consciousness of the reciprocal influence.

Several speakers criticized the tacit assumption of the Clapham Report that all social research was expensive. It was often implied, it was said, that most social inquiries involved questionnaires on a large and costly scale. The need for 'penetration' studies of the individual, of the kind made in social anthropology, tended to be overlooked. Measurement was not a *sine qua non* of social research. There was a complete absence to-day of really fundamental social research, with the possible exception of industrial psychology.

Before the meeting drew to its close, a national sectional committee of the Association of Scientific Workers was set up with the terms of reference as described above, and the members duly elected.

John Cohen

BRITISH CONTRIBUTION TO RADIOLOCATION

Early in March 1946, the Institution of Electrical Engineers held a Radiolocation Conference at which were presented a large number of lectures and papers by various members and other individuals who had contributed to the development and application of radiolocation during the war years. The Convention was formally opened at an ordinary meeting of the Institution by the Minister of Supply, Mr. John Wilmot, and was followed by a lecture on "The Evolution of Radiolocation" by Sir Robert Watson-Watt. In the course of this lecture it was explained that the object of the Convention was to describe and discuss British activities in this subject, which began in February 1935 and were at first conducted independently of any similar work elsewhere. Following the co-operation established between Great Britain and the United States in the autumn of 1940, later developments were conducted on the basis of a United Nations' system for which the name 'radar' was adopted in 1943, this term being then in current use in the United States.

The opening meeting referred to above was followed by twelve special meetings of the Radio Section of the Institution devoted to lectures and papers on special portions of the technical field of development and their applications. The wide range of subjects dealt with is indicated by the titles adopted for these meetings: "Aerials and Wave Guides"; "Propagation"; "Cathode Ray Tubes"; "Precision Radar"; "Valves"; "Radio Measurements and Test Gear"; "Shipborne Radar"; "Transmitters and Receivers"; "Circuit Techniques for Radiolocation"; "Radar Navigation" (two meetings); and "Naval Gunnery Radar". At most of these meetings one or two papers were first read, giving a general survey of the portion of the field under discussion; and these were followed by a series of brief lectures by experts on particular sections of the subject. Three of the meetings were each devoted to a formal lecture on a phase of the subject to which special attention had been given by the Army, Navy and Air Force respectively. The authors of all these contributions, the total number of which exceeds 160, included members of the staffs of various Government establishments, industrial organisations and universities, who had co-operated in the very large amount of research and development work undertaken during the war years.

The *Proceedings* of this Radiolocation Convention are now being published as nine special numbers of Part 3 of the *Journal of the Institution of Electrical Engineers*, of which the first two, Vol. 93, Part 3 A, Nos. 1 and 2, have recently been issued. The first number comprises a basic record of all the meetings described above, the survey papers and some of the lectures being published in full; while abstracts of the remaining lectures and of the supporting papers, the full texts of most of which will appear in later numbers, are also given, together with some sectional bibliographies of other supporting papers to be published later. This publication thus forms a most useful work of reference to the whole literature so far available describing the British contribution to the technical development of radar or radiolocation.

The second number (Vol. 93, Part 3 A, No. 2) of this special issue of the *Journal* contains the full text of the six papers read at the session on "Naval Gunnery Radar", of the four papers read at the session on "Radar Navigation", and of two papers dealing with certain aspects of the technique of "Precision Radar". This publication will be found of great use to those responsible for detailed research and technical development in these subjects, of which radar as an aid to both aerial and marine navigation is already well advanced in its civil applications.

FORTHCOMING EVENTS

Monday, February 3

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. A. Dickson Wright: "The Possibilities of Recent Discoveries in Medical Diagnosis and Treatment" (Cantor Lectures, 2).

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Inaugural Meeting for 1947. Mr. Victor S. Wigmore: Presidential Address; Mr. A. E. Turner will present the Premiums awarded in 1946.

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. Norman Pye: "Hyperbolic Navigational Charts".

Society of Chemical Industry, Food Group (joint meeting with the London Section, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. E. Griffiths and Mr. F. R. Jones: "Refrigeration—Development and Application".

Tuesday, February 4

Institution of Chemical Engineers (joint meeting with the Road and Building Materials Group of the Society of Chemical Industry, at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1).—Conference on "Particle Size Analysis". At 10 a.m.—"Methods of Measurement"; at 2 p.m.—"Industrial Applications".

Wednesday, February 5

Royal Society of Medicine, Historical Section (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Dr. W. R. Bett: "On Style in Medical Literature—Traditions, Circumstances, Diversions and Lethargies".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. Domb and Dr. M. H. L. Pryce: "The Calculation of Field Strengths over a Spherical Earth".

Society of Public Analysts and other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Scientific Papers.

Thursday, February 6

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 11 a.m.—Conference on "Proposed International Exhibition in 1951".

Royal Society of Arts, India and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Herbert Howard: "The Forests and Forest Resources of India".

Linnean Society of London (joint meeting with the Systematics Association, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "The Teaching of Taxonomy" (Speakers: Sir Clive Forster-Cooper, F.R.S., Prof. James Gray, F.R.S., Dr. W. B. Turrill and Prof. A. R. Clapham).

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. Hacking and Mr. J. D. Peattie: "The British Grid System in Wartime".

Institute of Economic Engineering, Midland Section (at the Chamber of Commerce, Birmingham), at 7 p.m.—Mr. C. D. Pollard: "Time and Motion Study in the Foundry".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Dr. A. E. Alexander: "The Application of Surface Chemistry to Colloidal Problems" (Tilden Lecture).

Friday, February 7

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "What has the Electrical Instrument Industry to learn from Developments in Continental Practice?" (to be opened by Mr. F. E. J. Ockenden and Mr. G. N. Harding).

Institution of Mechanical Engineers, Applied Mechanics Group (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. A. Porter: "Basic Principles of Automatic Control Systems".

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. J. M. Bruckshaw: "Application of Geophysics to Geological Problems".

Chemical Society (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, at University College, Cardiff), at 6.45 p.m.—Prof. W. Wardlaw: "Structural Inorganic Chemistry".

Textile Institute, Dublin Branch (at the Mansion House, Dawson Street, Dublin), at 7.30 p.m.—Mr. E. Waters: "Nylon Textiles—their Properties and Processing".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. James Gray, F.R.S.: "Vitalism, Old and New".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Gas Examiner—The Town Clerk, Municipal Offices, Bromley, Kent, endorsed 'Gas Examiner' (February 7).

Farm Manager—The Director, Agricultural Research Council, Field Station, Compton, Berks. (February 10).

Head of the Establishment, Survey Production Centre, R.E., Hanwell, under the War Office—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1777 (February 15).

Junior Chemist and a Junior Physicist—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (February 15).

Assistant Superintendent (Research), Government Livestock Farm, Hissar, in the Punjab Veterinary Service, Class I—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 306 (February 15).

Geologist for the Government of the United Provinces, India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 298 (February 15).

Clinical Chemist to be responsible for tests and investigations of a chemical nature in the Clinical Pathology Department—The Secretary, University College Hospital Medical School, University Street, London, W.C.1 (February 28).

Senior Lecturer (Grade I) in the Department of Electrical Engineering (Electronics)—The Registrar, The University, Liverpool (February 28).

Readership in Physical Chemistry tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 4).

Senior Lecturer in Anatomy (Histology)—The Registrar, The University, Sheffield (March 8).

Chair of Chinese Art and Archæology tenable at the Courtauld Institute of Art—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 11).

Official Fellowship in Natural Sciences or Medicine—The Master, St. Catharine's College, Cambridge (March 31).

Lecturer (Grade IIb) in Mechanical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (March 31).

Senior Lecturer in Anatomy—The Registrar, The University, Sheffield (April 1).

Senior Lecturer in Zoology—The Registrar, The University, Sydney, Australia (April 5).

Speech Therapist—The County Medical Officer, County Hall, Hertford.

Lecturer in Physics (with subsidiary Mathematics)—The Registrar, Merchant Venturers' Technical College, Unity Street, Bristol 1.

Lecturer in Chemistry, a Lecturer in Botany, and an Assistant Lecturer in Science Subjects—The Principal, Kingston Technical College, Kingston Hall Road, Kingston-upon-Thames, Surrey.

Biologist on the staff in Tanganyika Territory—The Secretary, Empire Cotton Growing Corporation, 1a Harrington Road, London, S.W.7.

Senior Bacteriologist to the Royal Sheffield Infirmary and Hospital and Honorary Lecturer in the Bacteriology Department of the University of Sheffield—The General Superintendent, Royal Infirmary, Sheffield 6.

Lecturer in Geology, an Assistant Lecturer in Horticulture, a Lecturer in Social Philosophy, and a Library Assistant—The Registrar, University College, Exeter.

Scientific Liaison Officer, and a Technical Liaison Officer, in the Department of Scientific and Technical Liaison in the London Offices of the Secretariat—The Secretary, International Wool Secretariat, Dorland House, 18–20 Regent Street, London, S.W.1.

Junior Research Officer (with honours degree in Physics or Engineering) for research on the mechanics of cloth formation, and a Research Officer (male) for research on development and application of analytical methods—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Hydrographical Surveyors (Grade III), by the Government of Iraq for the Basrah Port Directorate—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.17048.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Standard 1270 : 1946. Schedule for Electric Discharge Lamps for General Purposes. Pp. 8. (London: British Standards Institution, 1946.) 2*s*. net. [1010

Imperial Bureau of Horticulture and Plantation Crops. Technical Communication No. 18: Fruit Fall and its Control by Synthetic Growth Substances. By Dr. M. C. Vyvyan. Pp. 72. (East Malling: Imperial Bureau of Horticulture and Plantation Crops, 1946.) 3*s*. 6*d*. [1410

Edinburgh and East of Scotland College of Agriculture. Technical Bulletin No. 1: Investigations on Bovine Mastitis, 1, Bacteriological Diagnosis by Plating Methods. By A. Cunningham, Anna C. Stirling, Joan K. B. Raymont and Margaret A. Wilson. Pp. 20 + 2 plates. (Edinburgh: Edinburgh and East of Scotland College of Agriculture, 1946.) [1410

The Registrar-General's Statistical Review of England and Wales for the Year 1942. Tables, Part 1: Medical. Pp. vii + 320. (London: H.M. Stationery Office, 1946.) 5*s*. net. [1410

Forestry Commission. Bulletin No. 8: British Bark-Beetles. By Dr. J. W. Munro. Reprint. Pp. 77 + 10 plates. (London: H.M. Stationery Office, 1946.) 3*s*. 6*d*. net. [1410

Ministry of Agriculture and Fisheries. Bulletin No. 109: Commercial Flower Production, Part 2, Summer Flowers. By Dr. H. V. Taylor and Dr. Katharine H. Johnstone. Reprint of 1939 edition. Pp. vi + 62 + 10 plates. 1*s*. 6*d*. net. Bulletin No. 110: Commercial Flower Production, Part 3, Foliage and Foliage Plants. By Dr. H. V. Taylor and Dr. Katharine H. Johnstone. Reprint of 1938 edition. Pp. iv + 56. 1*s*. net. Bulletin No. 112: Commercial Flower Production, Part 4, Flowering Plants in Pots. By Dr. H. V. Taylor and Dr. Katharine H. Johnstone. Reprint of 1939 edition. Pp. vi + 56 + 12 plates. 2*s*. net. (London: H.M. Stationery Office, 1946.) [1410

Overhead-Line Charts: a Series of Charts giving Load-Carrying Capacity and Voltage Drop for Line Voltages of from 400V to 264kV. By J. S. Forrest. Pp. 20. (London: *Electrical Review*, Ltd., 1946.) 2*s*. 6*d*. [1510

Apparent Places of Fundamental Stars, 1946: containing the 1535 Stars in the Third Fundamental Catalogue (FK3) of the Berliner Jahrbuch. (Published by order of the Lords Commissioners of the Admiralty.) Pp. xxxii + 538. (London: H.M. Stationery Office, 1945.) 42*s*. net. [1510

Research Association of British Rubber Manufacturers. Twenty-sixth Annual Report for the Year 1945. Pp. 37. (Croydon: Research Association of British Rubber Manufacturers, 1946.) [2110

Ministry of Fuel and Power and the Department of Scientific and Industrial Research. Domestic Heating in America: a Study of Heating, Cooking and Hot Water Supply in Small Houses in U.S.A. and Canada. Pp. x + 152. (London: H.M. Stationery Office, 1946.) 3*s* .net [2110

Forestry Commission. Bulletin No. 14: Forestry Practice; a Summary of Methods of Establishing Forest Nurseries and Plantations, with Advice on other Forestry Questions, for Owners, Agents and Foresters. Revised edition. Pp. v + 92. (London: H.M. Stationery Office, 1946.) 2*s*. net. [2110

Other Countries

Scientific Reports of the Imperial Agricultural Research Institute, New Delhi, for the Year ended 30th June 1945. Pp. 93. (Delhi: Manager of Publications, 1946.) 1.10 rupees. [2410

Indian Forest Records (New Series). Silviculture, Vol. 6, No. 1: An English Translation of the Results of an Erosion Experiment published in the Proceedings of the Swiss Forest Research Institute, Vol. 23, Part 1, 1943, by Hans Burger. Translation by Dr. A. L. Griffith and C. W. A. Sondermann. Pp. vi + 61 + 3 plates. (Dehra Dun: Forest Research Institute, 1946.) 1.11 rupees. [2410

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 194: A Procedure of Investigation in Fisheries Biology. (Division of Fisheries, Report No. 11.) By G. L. Kesteven. Pp. 31. Industrial Chemistry Circular No. 5: The Significance, Measurement and Control of Hydrogen Ion Concentration. By Dr. Allan Walkley. Pp. 30. (Melbourne: Government Printer, 1946.) [2810

South Australia: Department of Mines. Mining Review for the Half-Year ended 30th June, 1945. (No. 82.) Pp. 133. (Adelaide: Government Printer, 1946.) [2810

Transactions of the American Philosophical Society. New Series, Vol. 35, Part 4: A Census of the Determinable Genera of the Stegocephalia. By Prof. E. C. Case. Pp. 323-420. (Philadelphia: American Philosophical Society, 1946.) [2810

West China Union University Museum. Guidebook Series No. 6: An Introduction to Tibetan Culture. By Cheng Te-k'un and D. Michael Sullivan. Pp. 40. (Chengtu: West China Union University Museum, Hwasipa, 1945.) [2810

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Kungl. Lantbrukshögskolans Annaler (Annals of the Royal Agricultural College of Sweden.) Vol. 13. Pp. v + 296. (Uppsala: Kungl. Lantbrukshögskolan, 1946.) 15 kr. [2810

Ministry of Public Works, Egypt. Physical Department Paper No. 52: Earth and Water Temperatures in Egypt. By L. J. Sutton. Pp. v + 91. (Cairo: Government Press, 1946.) [2910

Fouad I University: Faculty of Science. Annual Report, 1944–1945. Pp. v + 28. (Cairo: Fouad I University Press, 1946.) [2910

Western Australia: Department of Mines. Mineral Resources of Western Australia, Bulletin No. 1: Census of Western Australian Minerals. By Dr. Dorothy Carroll. Pp. 72. (Perth: Government Printer, 1945.) [3010

Banana Leaf Spot (*Mycosphaerella musicola*) on the Gros Michel Variety in Jamaica: Investigations on the Aetiology of the Disease and the Principles of Control by Spraying. By R. Leach. Pp. 118 + 19 plates. (Kingston: Government Printer, 1946.) 2*s*. [3010

Meddelande från Lunds Astronomiska Observatorium. Ser. 2, Nr. 113: A Photometric and Statistical Investigation of 1119 Stars in the Hyades Region. By Erik Holmberg. Pp. 107. Ser. 2, Nr. 114: A Photographic Photometry of the Spiral Nebulae NGC 891 and NGC 3623. By Erik Holmberg. Pp. 27. Ser. 2, Nr. 115 (Historical Notes and Papers Nr. 20): Alt-Uppsala und Urnes; Untersuchung zur Entstehung der Dreischiffstabkirche und des ältesten Germanisch-Heidnischen Kulthauses. Von Åke Ohlmarks. Pp. 30. Ser. 2, Nr. 116: A Study of Visual Binary Stars, with regard to the Errors of Observation and the Problem of Orbit Determination. By Bengt Ekenberg. Pp. 190. 10 kr. Ser. 2, Nr. 117: On the Apparent Diameters and the Orientation in Space of Extragalactic Nebulae. By Erik Holmberg. Pp. 82. Ser. 2, Nr. 118: Proper Motions of 98 Red Variable Stars. By Frida Palmér. Pp. 10. Ser. 2, Nr. 119: Studies of Bright Diffuse Galactic Nebulae, with special regard to their Spatial Distribution. By Sven Cederblad. Pp. 116. 10 kr. (Lund: Astronomiska Observatorium, 1944–1946.) [3010

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SCIENTIFIC MAN-POWER IN BRITAIN

THE Parliamentary and Scientific Committee has produced a useful report on "Universities and the Increase of Scientific Man-power", which is neither rigid nor excessively weighted by the statistical factor. The general tenor of the report of the Barlow Committee is endorsed, although the view is taken that the relative pre-war weakness of British economy in the application of scientific methods suggests aiming at less than an approximate doubling of our estimated pre-war scientific man-power. In setting a target of 100,000 qualified scientific workers by 1955, the Committee expresses the view that there is room for expansion of the industrial research associations, and refers also to defence research, medical and veterinary science and the Agricultural Advisory Service as likely to call for many more scientific men, apart from the probable increase in industrial requirements. It emphasizes the first-class importance of the question of qualifications, and that quality, as well as quantity, must always be kept in mind. Like *Planning*, in its broadsheet, "Britain's Need for Man-power", it presses for an early inquiry into the probable ultimate demand for each particular category of scientific worker, so as to avoid inducing young men and women into courses of study which do not lead to satisfying careers.

Probably the most important recommendation in this report is that such an inquiry should be set on foot forthwith, and it should engage the active attention of the Ministry of Labour as well as of the professional organisations and the university appointment boards. To achieve even the total of 90,000 qualified scientific workers recommended by the Barlow Committee will scarcely be possible by 1955 unless the output from the universities increases faster than the Barlow Committee proposes; but the Parliamentary and Scientific Committee accepts a doubling of the output as the most that can be asked of the universities in the immediate future. Moreover, it agrees with the Barlow Committee that the increase in the number of scientific graduates should be balanced by a substantial increase in the number of students studying the humanities; and it proceeds to discuss university expansion on the basis of doubling the entire university output of graduates.

The primary and most obstinate difficulty in such expansion is the provision of sufficient and well-qualified teaching and research staff. The Parliamentary and Scientific Committee believes that the present shortage of staff will restrict the expansion of universities until 1949–50, when it should be possible to double the annual intake; and that, at least in the sciences, with which the Barlow and the present reports are immediately concerned, it should be practicable to double the well-qualified academic staff during the next four years, bringing the present total of 4,000 university teachers to 8,000–10,000. The first step is, of course, to ensure that the staff expands at least as rapidly as the student population; and the report also emphasizes what has already been said in many earlier reports with regard to adequate salaries, maintaining a proper balance of teaching and research time and generally making university teaching a sufficiently satisfying career to attract the right kind of people. It directs attention, moreover, to the importance of accommodation, both for teaching and for research, and to the need for the generous grant of priorities by the Government in these respects and also in the matter of hostel accommodation and the like.

So far as the distribution of the proposed expansion between different institutions is concerned, the Parliamentary and Scientific Committee fully endorses the recommendations of the Barlow Committee, but suggests further that difficulties in the expansion of the newer civic universities, where the major expansion must occur, might be overcome by migration of the university from the centre of a city to its outskirts. In London, it is thought there might with advantage be as many as four universities, and the Committee suggests decentralization or actual division, with a target figure of 25,000 students or more. At Oxford and Cambridge, an increase in the annual number of science students might be expected, for at Oxford in 1939 they formed only 10 per cent of the total; and apart from the immediate post-war 'bulge', these two universities might well contribute a total increase of 2,000 science students over the next five to ten years. While, however, some of the existing university colleges, such as Nottingham, should, in the Committee's opinion, now be raised to university status, and other university colleges such as Leicester and Hull should be fostered, the foundation of new universities is regarded as inexpedient, and likely to hinder rather than help the immediate expansion.

The changes visualized in this report would give as the maximum expansion over the next five years a total of 108,000 undergraduates. If the building programme involved is to be accelerated, it is important for the right type of information to be available to the appropriate Government departments in the right form, and the Parliamentary and Scientific Committee directs attention to the value of a schedule setting out the precise amount of accommodation required, faculty by faculty, throughout the country, with a cross-index against universities, expressed in a uniform and easily understood unit of measurement. Early provision of such a schedule would facilitate the integration of university requirements with the rest of the national demand for building labour and materials, and might assist in procuring the priorities which are the first and most urgent need. Incidentally, the need for providing the University Grants Committee with appropriate staff and secretariat is again stressed; and while the Parliamentary and Scientific Committee recognizes that the required expansion should proceed without any loss of independence on the part of the universities, it looks for much more positive action by the University Grants Committee. Not only should this Committee be strengthened, but also at the same time the Vice-Chancellors' Committee should be provided with an adequate permanent secretariat; there is also need for a general forum for the interchange of views between all the universities at all levels and in all the fields concerned, and comprising principals, administrative and teaching staff.

The report does not press quite so firmly for an active and consultative body, such as a universities council, as recommended in its earlier report; but the University Grants Committee, by implication at least, seems to be the body to be charged with the responsibility for planning university expansion. The cost of that expansion is put by the Parliamentary and Scientific Committee in the region of £100 millions for capital expenditure over the next ten years, and it suggests that an appropriate sum should be earmarked for the purpose by the Chancellor of the Exchequer, at least for five years, so as to facilitate planning with confidence. The annual cost of expansion is put at £10 millions, or a total expenditure of £30 millions annually on the universities, a figure which agrees with that given by the *Economist* last year; in particular, it is urged that, so far as possible, no young person of requisite ability should be prevented by financial considerations from participating in these increased facilities for university education.

The proposed expansion of the universities of Britain cannot, of course, be realized without a parallel expansion of the secondary schools; and important as is generous financial assistance from the Government, that alone will not suffice under present conditions. The highest priorities must also be given for the man-power and materials required for building the increased accommodation that expansion involves.

When we have provided the machinery for training the man-power required to meet the needs anticipated in the professions, in industry and in business during the next ten years or so, and have done something to ensure that the standards of management are such that unnecessary wastage is eliminated, there still remains the arrangements for recruitment, which are surveyed in some detail in the second part of the *Planning* broadsheet on "Britain's Need for Brain-power". Such arrangements should endeavour to secure recruits of the highest possible quality, the broad adjustment of supply to the demand, and a reasonable distribution of the most able men and women among the various callings. The latter objective may be the most important at a time of acute shortage of man-power, as without some system of priorities, bottle-necks may be created which hinder the further expansion of man-power; for example, if too many scientific workers are attracted into industry or the Government service, then the universities may be unable to expand their teaching and research staffs appropriately. All three alike involve energetic measures to provide advice and information about careers, to ensure financial assistance to those who, though suitable, would otherwise be unable to undertake the necessary training, to improve methods of selection, to secure that salaries and conditions are reasonably well balanced between the major callings, and to tap all sources of recruitment.

Implementation of the recommendations of the Hankey Committee on Higher Appointments would place the relevant facts at the disposal of young people deciding on a career, although the schools, universities and professional institutions might also make important contributions. Methods of selection, however, are specially important at the present time. Upon their efficiency depends the success of a profession or organisation in obtaining the best recruits available, while upon their reputation for fairness depends to some extent the quality of the young men and women who come forward. *Planning* urges that a proportion of university scholarships should be awarded for outstanding personal qualities combined with good intelligence rather than for purely academic attainments, and that the scientific techniques of selection developed in the Services should be further explored and turned to account. The universities and other training institutions should give attention to the co-ordination of standards of selection, to avoid a situation in which variations in the ratio of applicants for vacancies may lead to one university accepting students of a standard rejected by another. Moreover, in this connexion there must be borne in mind the considerations brought to light in Sir Cyril Burt's study, "Intelligence and Fertility". If the present differential birth-rates are in fact not only lowering the level of innate general intelligence but even threatening to reduce by fifty per cent in the next half-century the number of children of scholarship ability in the schools, the selection of university students as well as the use of graduates will require even closer study by the universities as well as by professional bodies, industry and the Government.

Other factors noted by *Planning* indicate the many ramifications of the man-power problem, and no doubt they are receiving careful study by professional associations. To expand to the full the limited resources in Great Britain of trained man-power, and to ensure that it is reasonably distributed and used with the maximum economy, are matters which demand much more than Government initiative alone. The universities are concerned at both the beginning and end of any scheme, in that they must consider sources of supply, training and the placing of students; and throughout there must be the fullest co-operation with management in industry, commerce and departments of State.

VERNALIZATION AND PHOTOPERIODISM

Crop Production and Environment

By R. O. Whyte. Pp. 372+32 plates. (London: Faber and Faber, Ltd., 1946.) 25*s*. net.

THE scope of this book is much narrower than its title suggests, for it deals with only one aspect of crop production, and only two out of the whole complex of environmental factors. Its subject is the effect of temperature and of light on the 'development' of plants, defined by the author as "the progress towards reproduction by externally recognizable or invisible stages", as distinct from 'growth' in the sense of dry matter accumulation or increase in size. As the author points out, this separation of the two aspects of growth, in the wider sense, is open to criticism, though it may be justified by experimental convenience. 'Development' and growth are not independent, as is very obvious in agricultural practice, where the object of controlling 'development' is to increase 'growth' as measured by the harvested yield.

Developmental physiology was brought into prominence by the discovery of the phenomenon of photoperiodism by Garner and Allard, and of the process of vernalization by Lysenko. Garner and Allard showed that sexual reproduction can be attained by a plant only when it is exposed to a specifically favourable length of day. Lysenko and his colleagues followed up the work of Gassner, who found that winter forms of cereals differ from spring forms in that their flowering is dependent on exposure to low temperature. They showed that the low-temperature treatment was effective at a very early stage of germination, or even during the growth of the grains in the ear of the parent plant. Partially sprouted grains of winter forms, after a period of exposure to low temperature, behaved like spring forms when sown, and were, therefore, said to be vernalized.

These observations have been greatly extended during the past twenty-five years, the developmental physiology of many species has been investigated, and attempts have been made to determine the nature of the internal processes which control the course of development. Much of this work has been done in the U.S.S.R., and unfortunately its design and interpretation have been limited by an uncritical acceptance of Lysenko's theory of phasic development. This postulates that the development of an annual plant proceeds by a sequence of irreversible stages, each of which must be completed before the next can begin, and that different phases require different environmental conditions for their completion. The Russian workers have set out to identify these hypothetical phases, and to determine their duration and environmental requirements, rather than to make an unbiased analysis of the effects of environment on development. The author of this book has not attempted to interpret their results on a broader basis, although he points out that the work of Gregory and Purvis, and others, has provided convincing evidence of the incorrectness of the theory. Nevertheless, he has performed a useful service by abstracting the Russian literature and making it more accessible to English readers.

An account of the effects of temperature and of the duration and intensity of light on development is given in the first eight chapters of the book. The next four chapters discuss changes in the physiological processes of the plant which accompany vernalization, or induction of flowering by adjustment of the photoperiod. Although variation in several physiological attributes, including the carbon → nitrogen ratio, respiration and enzymatic activity, occurs in association with the change from a vegetative to a reproductive state, it is still not clear which, if any, of these variations are causal, and which consequential. The existence of specific flower-forming substances or hormones is suggested by experiments which show, for example, that photo-induction can be transmitted from a single leaf or part of a leaf to the rest of a plant held in a photoperiod unfavourable for flowering, or across grafts, even when union of the cut surfaces is incomplete, but no such hormone has yet been isolated. Hormones have also been invoked to explain the vernalization effect, but the suggestion that the hastening of development is caused by an accumulation of auxin in the embryo during low-temperature treatment has recently been shown to be erroneous. Further work on these lines is very desirable, for until the physiological nature of developmental response is known, it will be difficult to systematize the great mass of empirical data which has accumulated.

The remainder of the book discusses the application of developmental physiology to problems in the geographical distribution of plants, to plant breeding, and to agriculture and horticulture. Direct control of the development of glasshouse crops is fairly easy, and is already being practised; but there seems to be little scope for this in agriculture, because the only environmental factors readily controllable in the field are the supplies of nutrients and water. However, as the author points out, a knowledge of the developmental requirements of crops should assist in the breeding of varieties which will attain the required state of development in whatever environment the crop is to be grown. Treatments involving critical manipulations, such as vernalization, may be of temporary value when the area of cultivation of a crop is being extended, but it seems that they are likely to go out of use when varieties suited to the new conditions become available. This, apparently, is already happening to the vernalization method in the U.S.S.R.

It is regrettable that the style in which this book is written does not do justice to the interest and importance of its subject. Most of the book consists of a succession of abstracts of published papers, often with little obvious connexion between one paragraph and the next. Consequently, the exposition lacks a co-ordinated plan and systematic development. Some of the abstracts include statements which are not relevant to the subject under discussion, so that the reader is misled into seeking a significance where none exists. The conclusions are sometimes so condensed as to be either unintelligible or platitudinous. Another objectionable feature is that many of the fifty-three figures are not referred to in the text, or are inserted at places remote from the text-reference. The legends attached to the figures are rarely sufficiently detailed to make the figures self-explanatory, or to show their significance in relation to the text.

D. J. WATSON

COLOUR VISION

Researches on Normal and Defective Colour Vision

By W. D. Wright. Pp. xvi+383. (London: Henry Kimpton, 1946.) 36*s*. net.

THIS book is primarily an account of the researches on colour vision carried out by the author and various co-workers in the technical optics department of the Imperial College of Science and Technology over a period of twenty years. Most of the work has been published, from time to time, as papers in scientific journals or special reports of the Medical Research Council; but in this book it is re-written as a logically connected story. This adds much to its value, not only by placing the various investigations in their proper perspective relative to each other, but also by collecting between one pair of covers material for which the student has hitherto had to search through many channels.

When Dr. Wright initiated his programme of work on colour vision twenty years ago, he had a very open field in which the problem was not to find something worth investigating but to decide where to start. Not that the field was unexplored. On the contrary, almost any problem on colour vision which one could formulate had already been investigated—generally by many workers—and had considerable literature devoted to it; but, despite this, there was scarcely one to which a satisfactory solution had at that time been found. This was undoubtedly due not to the lack of competent theorists but to the ill-defined and often conflicting data provided by the experimenters. Vision, like other so-called psychophysical subjects, is of interest to the physicist, physiologist and psychologist. All three have contributed to its investigation and discussion, each bringing different qualifications to the task. In many respects this three-directional approach has been beneficial: in fact, it is clearly necessary to a proper understanding of any sensory problem; but in one important respect it has made matters difficult. Much of the experimental work reported in the literature has been carried out by investigators who have lacked the competence in physical experimentation necessary to produce accurate results of clearly defined significance, and because of this the literature contains a great mass of apparently conflicting information which provides a headache for the critical theorist and a plentiful choice of alternative inspirations for the uncritical.

The value of the work of Wright and his colleagues lies in the fact that it is an attempt to re-survey the measurable aspects of visual behaviour under properly controlled experimental conditions—to provide a body of factual information which, however difficult it may still be to correlate and explain by a simple and all-embracing theory, can be stated unambiguously, and with all relevant detail, in clearly defined terms. Considerable as their success has been, their task is by no means completed, and Dr. Wright, in his preface, still describes the subject as one in which "so little is known about so much". The description is just, even at the present day; but the researches described in this book have undoubtedly helped to make the little considerably more than it was twenty years ago.

The book is divided into eight parts, of which the first consists of two introductory chapters dealing respectively with the physiological structure of the visual organ and with visual perception in general. The inclusion of these chapters is useful, as they treat their subject-matter in sufficient detail to fit the general reader for intelligent perusal of the later chapters without a troublesome amount of reference to other works. Part II is devoted to describing and explaining the operation of the author's trichromatic colorimeter, which, on account of its flexibility, can be adapted to a variety of purposes and is the basic instrument with which a considerable proportion of the researches have been carried out. Part III deals with luminosity measurements under various conditions of field size, field brightness and retinal region; Part IV with problems of colour mixture; Part V with problems of visual discrimination; Part VI with problems of adaptation; Part VII with defective colour vision; Part VIII with the interpretation of colour vision phenomena in terms of fundamental response curves. This skeleton summary of the contents, while it gives no idea of the amount and variety of the work recorded in the thirty chapters, will suffice to indicate the extent of the field which has been covered. The discussions of principles which occur throughout the book, and the theoretical explanations generally, are clearly written and should be easily followed by the average reader. For example, in explaining the significance of the spectral luminosity curve, the author manages in a few easy paragraphs to make clear the fundamental difference between the information provided by this curve and by the apparently similar spectral sensitivity curve of a purely physical light-sensitive apparatus such as a photocell. Failure to realize this difference has been the cause of much false reasoning by writers on the psychological implications of experiments on relative luminosities. His account of the principles of trichromatic colour measurement is based on a purely factual approach which strips it of all superfluous physiological or psychological assumptions.

Where so much is good it seems ungracious to complain, but the clarity of thought and diction which characterizes so much of the book seems, to the reviewer at least, to be missing from Chapter 23, on the measurement of subjective brightness. Discussion of the matter would be out of place here; but I am unable to discover what Dr. Wright means by subjective brightness—which he seems to identify with apparent brightness—or what he considers the 'brill' scale measures. The assumption that equality of contrast at different brightness-levels corresponds to equal differences of 'apparent' or 'subjective' brightness seems to underlie the treatment. This has no more justification than many of the other commonly made assumptions about relations between stimuli and sensations which are so ably refuted elsewhere in the book. This chapter is, however, a comparatively trivial interpolation in a volume which must be welcomed as a major contribution to the literature of colour vision. J. G.

WAR AND NATIONS

Human Nature, War and Society

By Dr. John Cohen. (Thinker's Library, No. 112.) Pp. x+193. (London: Watts and Co., Ltd., 1946.) 2*s*. 6*d*. net.

The Idea of Nationalism

A Study in its Origins and Background. By Prof. Hans Kohn. Pp. xiii+735. (New York: The Macmillan Company, 1946.) 36*s*. net.

The Decline of Liberalism as an Ideology

With Particular Reference to German Politico-Legal Thought. By John H. Hallowell. (International Library of Sociology and Social Reconstruction.) Pp. xiii+141. (London: Kegan Paul and Co., Ltd., 1946.) 12*s*. 6*d*. net.

German Youth

Bond or Free. By Prof. Howard Becker. (International Library of Sociology and Social Reconstruction.) Pp. xiii+286. (London: Kegan Paul and Co., Ltd., 1946.) 18*s*. net.

DR. J. COHEN'S stimulating pamphlet, "Human Nature, War and Society", does not claim to present more than a provisional hypothesis of the causes of war, and is in fact concerned rather with negative than with positive conclusions. We have long been familiar with the easy generalizations that evade the whole issue by finding the causes of war variously in human nature, armaments, biological necessity, animal aggressiveness or primitive savagery, and Dr. Cohen adduces ample evidence to dispose of these shirkings of the problem. "Human nature," he says, "is much maligned. It is unjustly held responsible for war and many other troubles which are really due to neglect or ignorance", and he makes a strong plea for 'scientific inquiry' to dispel ignorance, and by revealing the causes of war to render easier its control. But he has little that is constructive to offer. His thesis that war is the mark of civilized rather than of primitive societies is sound enough, but does not get us far, and he accepts rather too readily the common view that nationalism is a cause of war; it can equally be claimed to be a result of it. The remedy for war he finds in education and a 'world order' built in its earlier stages on such functional organisations as U.N.R.R.A. and F.A.O. (both of which, in spite of what he says on p. 176, are surely 'inter-national' rather than 'supra-national'). The choice of U.N.R.R.A. as an example was, perhaps, not altogether a happy one in view of recent events, and throughout his recommendations Dr. Cohen is impatient of current difficulties. There is more in Lord Beveridge's proposals, which he criticizes on p. 163, than he is prepared to recognize, at least at the present stage of world development. Nevertheless, Dr. Cohen has done useful work in sweeping away common fallacies and in directing attention to the need for that 'scientific' investigation of the causes of war that is the task of the historian. Scarcely less valuable, perhaps, would be a study of the wars that were prevented—an aspect of the subject that seems to have been overlooked.

Prof. H. Kohn has applied to the related problem of nationalism the 'scientific' treatment that Dr. Cohen advocates. "The Idea of Nationalism" is a solid compendium of information about the origins and development of the spirit of nationalism up to the time of the French Revolution, and, true to the American academic tradition, is heavily weighted with notes and references, which account for no less than one fifth of its total size. In effect, the work is a survey of the development of the European States system, and of much of the commentary of political thinkers at every stage of its growth. Judgments are sometimes summary, as in the statement on p. 132 that Francis I of France "succeeded in destroying the two pillars of medieval society—the feudal nobility and the Church", which says both too much and too little; but tribute must be paid to Prof. Kohn's industry and width of reading. The present volume is only preparatory, however: the real value of the study can scarcely be estimated until the next volume, dealing with nationalism in action, appears. For the present, we can but note Prof. Kohn's view that "nationalities are the product of the historical development of society"—an answer, if one were needed, to racial myths—and that they "defy exact definition". It would seem, therefore, that in their present form they are scarcely likely to prove permanent institutions, a view which Dr. Cohen will welcome.

Prof. J. H. Hallowell's "Decline of Liberalism as an Ideology" and Prof. H. Becker's "German Youth: Bond or Free" are recent additions to an unequal series. Prof. Hallowell is concerned with the decline of Liberalism in Germany as reflected in politico-legal thought; and in a survey of the writings of German thinkers throughout the nineteenth century he shows how Liberalism degenerated in academic theorizing, which gradually transformed the Liberal concept of the *Rechtsstaat* into an instrument of absolutism, and thereby prepared the way for the acceptance of Nazism by men who should have known better. The book presents a careful analysis of material which is necessary for the understanding of Nazi ideology; but the picture it gives is only a partial one. More needs to be said of the place of this politico-legal thought in the development of modern Germany and of the influence it exerted, before its significance in the tragic story can be correctly estimated.

Prof. Becker has taken another aspect of German life, the youth movements, and his book is claimed by the publisher to be "invaluable to all those concerned with the re-education of Germany". It is to be hoped, however, that the re-educators will know more about Germany and her past than this not very revealing work can tell them. A good deal has already been published about the youth movements that preceded Hitler's; Prof. Becker has little fresh light to throw on them.

MAURICE BRUCE

EXPLORERS OF CANADA

The Discovery of Canada

By Lawrence J. Burpee. Pp. x+280. (Toronto: The Macmillan Co. of Canada, Ltd., 1944.) 12*s*. 6*d*. net.

DR. L. J. BURPEE was well known as an authority on the exploration of Canada, and in this work naturally draws on his own researches. But the book is much more than repetition. It covers a long period, from the rather vague discoveries of the Norsemen to the voyage of Sergeant Larsen through the North-West Passage in 1940–42. It includes biographical notes on one hundred explorers and a detailed bibliography. A useful outline map forms the end papers.

The author's aim is to "let the story of the discovery of Canada tell itself", and this he does by introducing a large number of extracts from the writings of the explorers. These add greatly to the value of the narrative, though some are introduced for their personal appeal rather than for the light they throw on the progress of discovery.

The method adopted is to divide the country into four main areas—the Valley of the St. Lawrence, Hudson Bay and the Plains, the Pacific Slope, and the Far North—and to complete the story of each part. This has some disadvantages. We follow Mackenzie to the Pacific coast before we read of his earlier journey to the north, and we read in two separate sections of the work of David Thompson. There is, however, no easy way of dealing with such a large body of material, and Dr. Burpee does indicate, in his last chapter, some of the broad features which marked the progress of discovery. Of the early explorers, Dr. Burpee has little fresh to say, and wisely refrains from joining in controversy about landfalls of the Norsemen and John Cabot. But he does scant justice to Sebastian Cabot, for although he includes Dr. Williamson's classical study in his bibliography he makes no reference to the voyage of 1508–9. On evidence available at present there seems to be no reason to doubt that Sebastian discovered Hudson Bay on that voyage. Nor is Dr. Burpee entirely happy in his references to Drake and to Cook. Drake is said to have "rounded the Horn in 1578". He may have seen the southern end of South America, but he had sailed through Magellan's Strait and been driven south by storms. As, however, he never saw any part of Canada—and this may be said of several explorers who are included in the book—the error is of small importance. As for Cook he is described as having "explored the north-west coast of North America from Nootka Sound, in Vancouver Island, to Alaska". Actually his instructions, which he carried out faithfully, were to make for New Albion, the land of Drake's discovery, and then sail along the coast without delaying to explore it until he reached 60° N., that is, in the modern Alaska. Hearne had shown, as Dr. Burpee points out, that a passage in any lower latitude was unlikely to be found, and Cook's business was to find a passage rather than to explore a coastline. It was Vancouver as Dr. Burpee shows, who was the real explorer of this coast, and it is a pity that more space has not been given to his accurate, detailed, but often forgotten survey.

The publishers claim this as Dr. Burpee's "greatest contribution to Canadian history". We doubt if the author would have shared this view. None the less his book is full of learning and of human interest and can be read with profit and with pleasure by the serious student and by the general reader.

J. N. L. BAKER

BIOLOGY OF SEX HORMONES

Biological Actions of Sex Hormones

By Dr. Harold Burrows. Pp. x+514. (Cambridge: At the University Press, 1945.) 42*s*. net.

DR. H. BURROWS' volume provides a comprehensive summary of literature on the sex-hormones up to the period 1941–42. It is divided into six parts, which deal, respectively, with the gonadotrophic factors of the pituitary; the gonadal hormones in general; the androgens; the œstrogens; the progestational hormones; and the sex hormones of the adrenal cortex. The author has not excluded any material of importance, and because of the length of the book and his method of presentation, it has necessarily assumed more the character of a summary of what has been written on different topics than a review, the specific purpose of which would be to demonstrate the most fruitful trends of current research and a general synthesis of the subject. As Dr. Burrows himself states, his purpose was to produce "a co-ordinated summary of experimental enquiries" carried out in the laboratory. In this he has undoubtedly succeeded, even though one regrets that he has stopped short of providing the reader with his own general, or special, conclusions about the matters which he has treated.

The War has receded far enough for one to be aware of the debt that is owed to those who have made it possible for others to recapture the thread of fundamental science with speed and ease. The war years not only considerably slowed down the rate of basic research, by interpolating other more practical issues into the everyday life of the man of science; they also diluted the flow of interest in many fields of science, with the result that before resuming work, a great deal has to be done by the individual worker in reconcentrating his sphere of interest. This difficulty is particularly great in the more actively growing fields of science, and all endocrinologists will therefore owe a major debt of gratitude to Dr. Burrows for his painstaking service and solid achievement in pulling together the literature of the subject in so useful a form.

NATIONAL RESEARCH LABORATORIES OF INDIA

INTRODUCTION

By Sir SHANTI BHATNAGAR, O.B.E., F.R.S.
Director, Scientific and Industrial Research, India

THE importance of scientific research and of the application of scientific knowledge to all national reconstruction activities has been fully realized in India in recent years. In order to organise co-ordinated research in the several sciences fundamental to the welfare and progress of the country, it was considered desirable to establish laboratories in which scientific and industrial research could be carried out on a sufficiently large scale commensurate with our future industrial potential, and a proposal to this effect was first initiated by the Director of Scientific and Industrial Research in September 1941.

It will, perhaps, not be out of place to give here a brief account of the early work of the Council of Scientific and Industrial Research, as the present plans for the Laboratories have a direct bearing on it. It may be recalled that a Board of Scientific and Industrial Research was set up by the Government of India in 1940, and this was followed by the setting up of the Council of Scientific and Industrial Research in 1942 to control and co-ordinate the activities of the Board and of the newly created Industrial Research Utilization Committee. This was the first concrete step taken by the Government towards placing industrial research on its feet in India, though the immediate need arose mostly out of demands made by the War. The War provided an effective stimulus to the activities of the Council, which steadily increased even with the limited facilities available, since any large expansion scheme was ruled out by difficulties in obtaining building materials, laboratory equipment, services of experts, etc. The initial experience during the war-period, however, served the useful purpose of bringing to light the inadequacy of the existing organisation and thereby focusing public attention on the necessity for expanding the facilities available for research as an important national problem.

Accordingly, in the following year, the Council approached the Government of India with a post-war plan for the establishment of five national laboratories and research institutions; namely, a National Physical Laboratory, a National Chemical Laboratory, a National Metallurgical Laboratory, a Central Glass and Ceramic Research Institute, and a Fuel Research Institute. The scheme was formally approved by the Government, and active planning work for the five laboratories was started soon after, by the setting up of expert committees for drawing up detailed plans and estimates for each of the laboratories. The Government announced a capital grant of Rs. 1 crore for the establishment of these laboratories, and also allotted a spacious site of more than sixty acres of land in New Delhi for the location of one of the national laboratories. Considerable public interest was evinced in the Council's scheme, and several industrialists came forward with donations towards the cost. The House of Tatas gave Rs. 20 lacs towards two of the laboratories—the National Chemical Laboratory, Rs. 8·3 lacs, and the National Metallurgical Laboratory, Rs. 11·7 lacs. The Indian Steel and Wire Products, Ltd., gave Rs. 1 lac, and the late Mr. D. P. Khaitan and the Indian Metallurgical Association gave Rs. 25,000 and Rs. 10,000 respectively. A prominent landlord, the Raja of Jharia, made a gift of 100 acres of land in Dhanbad —the heart of the coal-fields area—for the location of the Fuel Research Institute.

In planning the National Laboratories, the committees responsible have been fully alive to the immediate needs, and have also tried to meet future requirements by drawing up both short- and long-term programmes of work for each Laboratory. When completed, the Laboratories will cover all aspects of research in their respective fields, and will have semi-process or pilot-plant facilities for determining the value of the investigations to industry.

Standardization is another aspect of work which has not hitherto received sufficient attention in India. The Indian Standards Institution, which has just recently been established, will require considerable scientific assistance in its various technical committees, and the co-operation of the National Laboratories will go a long way towards establishing industrial standards suitable for the needs of the country. In addition, the National Physical Laboratory will have the custody of the fundamental national standards of mass and length.

The subject of fundamental versus applied research has been recently discussed in many quarters. But research can scarcely be divided into water-tight compartments: such division is a purely scholastic distinction which ignores how scientific research develops. What is fundamental to-day may become very much of applied research in a very short while. In actual practice, both the theoretical and practical aspects of science have progressed by an intimate interplay. Any artificial separation will be either theoretically unsound or practically unworkable, and if enforced will render theory arid and practice a petrified routine. It is by the interchange of thought and work that the most fruitful results have emerged. The part which fundamental as well as applied research is likely to play in future developments in India has been fully recognized by the Planning Committees of the various National Laboratories. The scope of work in each Laboratory could, perhaps, be best described to be of "the form of a continuous spectrum, at one end of which research work of the purest academic type and of the highest quality is carried out and at the other, the technical development of processes and equipment proceeds by stages".

One aspect of fundamental research work which can scarcely be neglected in India is that which requires specialized large-scale laboratories. During recent years, and particularly during the Second World War, organisation of scientific work has undergone vast changes. Not only does some of the present type of work require large-scale specialized organisations well outside the scope of university work, but also expenditure of money running into millions which can only be justified if diversified, coordinated and regulated application and professional continuity of work are guaranteed. This is not usually possible in the universities, where teaching and research necessarily go hand in hand and are essentially preparatory. Fundamental research is fast becoming a huge organised industry in itself, and must be planned as such.

It is necessary to stress here the important fact that these National Laboratories are not intended to supplant but to supplement the work of individual or collective industrial concerns or universities in respect of research. They will undertake work of the kind that does not fall ordinarily within the scope of industries. Their approach to industrial problems will be from a broad national point of view, rather than from the narrow outlook of a particular industry. The Laboratories will be in a better position to employ suitable talent and to try alternative approaches to problems simultaneously, without being restricted by any ideas of immediate financial gains. As a general rule, problems which bear on wider social and economic aspects than any individual industry could be concerned with are of necessity subjects of State scientific research, and it is in this spirit that the Laboratories will fulfil their functions.

In concluding this introduction, I may quote the words of Pandit Jawaharlal Nehru when laying the foundation-stone of the National Physical Laboratory: "when I look at the picture of new India that is emerging, I feel sorry that I may not be there to see it in its full glory; nevertheless, it is glory enough to take part in the building of it".

THE NATIONAL PHYSICAL LABORATORY OF INDIA

By Dr. K. N. MATHUR

Assistant Director (Planning), National Physical Laboratory of India

THE National Physical Laboratory of India, the foundation-stone of which was laid at Delhi on January 4, 1947, by Pandit Jawaharlal Nehru in the presence of a distinguished gathering of Indian and foreign men of science, including Sir Charles Darwin, director of the National Physical Laboratory, Teddington, and Sir Harold Spencer Jones, Astronomer Royal, is expected to fill a wide gap in the scientific and industrial organisation of India. At present there is no well-equipped laboratory in India which undertakes standards work, nor does India possess any standards of length or mass which could claim statutory acceptance or which could be reproduced with scientific precision for the use of industry. The foremost function of the new Laboratory will be, therefore, the maintenance of fundamental and derived standards and the undertaking of research with the view of achieving a high degree of accuracy in the measurement and duplication of these standards. This will mean in practice that the Laboratory will have to undertake regular intercomparisons between its standards and those of other countries, which is the accepted method of all of the standards laboratories of the world.

Besides the fundamental standards of length, mass and time, there are direct derivatives of these, such as area, volume, density, velocity, etc., which have numerous industrial applications. In addition, scientific work as well as industry requires standards for a large number of other units, which only indirectly depend upon the fundamental standards, and the realization of which in practice requires scientific work of the highest precision. Some of the most important of these are the International Temperature Scale, over a wide range of temperatures; specific heats; conductivity; colour standards; electrical units such as the volt, ampere, ohm; standards of inductances and capacity; standard radio- and audio-frequencies; standards of luminous flux, etc. The great industrial expansion envisaged in the present plans of the Government of India will place a special responsibility on the Laboratory. This aspect of the Laboratory's work was emphasized by the Hon. Dr. John Matthai, Minister for Industries and Supplies, who is also the president of the Council of Scientific and Industrial Research, at the ceremony of laying the foundation stone of the Laboratory.

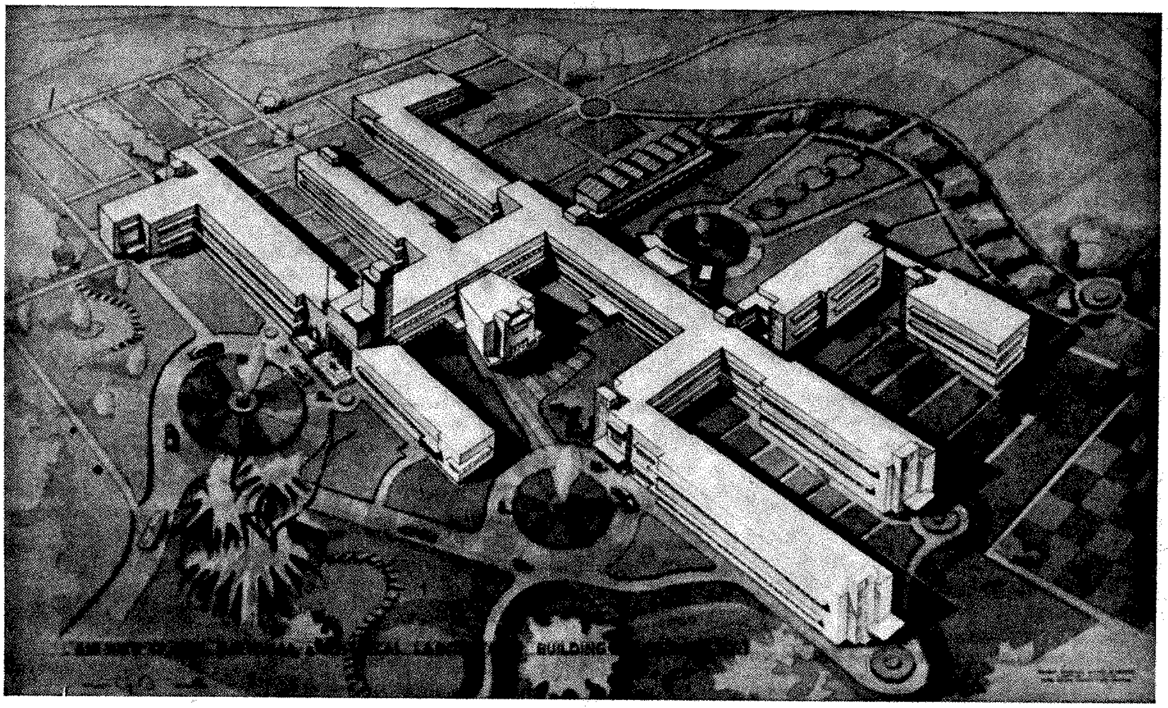

Fig. 1. ARCHITECT'S DRAWING OF THE NATIONAL PHYSICAL LABORATORY, INDIA

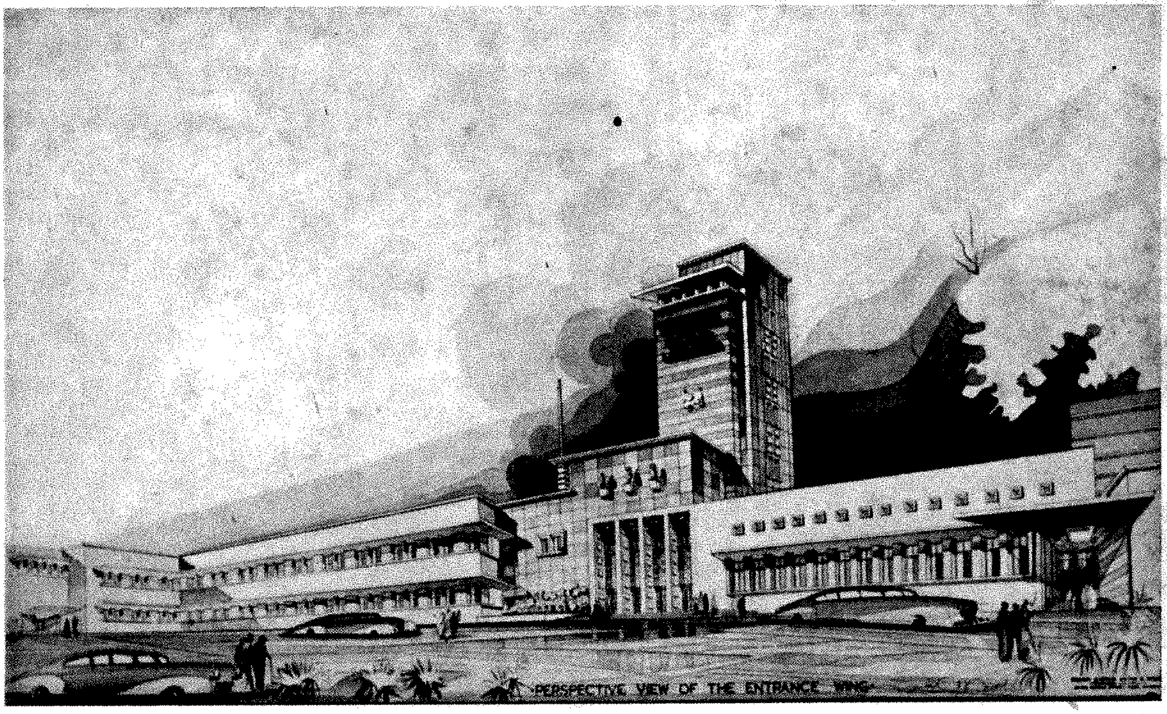
PERSPECTIVE VIEW OF THE ENTRANCE WING

Fig. 2. Entrance wing of the National Physical Laboratory, India

Scheme for the Laboratory

A comprehensive scheme detailing the scope, unctions, organisation, staff, etc., for the Laboratory vas drawn up by a Planning Committee, presided ver by Sir Ghulam Mohammad, and including some f the best-known Indian men of science, and has een published as a "Plan for a National Physical aboratory for India". This report, which was rawn up after consultations with the National hysical Laboratory, Teddington, and the National ureau of Standards, Washington, has been accepted y the Council of Scientific and Industrial Research, nd forms the basis on which the blue-prints of the aboratory have been drawn.

Divisions of the Laboratory

According to the Committee's recommendations, he work of the Laboratory will be carried on through ine Divisions, namely, (1) Weights and Measures ; 2) Applied Mechanics and Materials ; (3) Heat and ower ; (4) Optics ; (5) Electricity ; (6) Electronics nd Sound ; (7) Building and Housing Research ; 8) Hydraulics Research ; and (9) Analytical Chemstry. In addition to the above scientific divisions, he Laboratory will have (*a*) a central library with a ection dealing with research information for indusry, (*b*) central workshops, including glass-blowing nd -working shops, (*c*) general administration.

The Division of Weights and Measures will underake all the metrological work of the Laboratory nd will have the custody of the standards of mass nd length. It will have the responsibility for suplying sub-standards to other testing institutions. tandardization and checking of gauges, tapes, and hains, standard screws, hydrometers, barometers, olumetric glassware, all fall within its scope. This Division will also deal with the checking of watches nd chronometers, and will maintain standard timeeeping gear.

The Division of Applied Mechanics and Materials will be concerned with all problems of interest to engineers—elastic constants and the behaviour of materials under varying conditions of temperature and pressure, vibration and fatigue tests on materials under varying strains and with different types of loads, creep in metals, fluid friction, lubrication, etc.

The Division of Heat and Power will be responsible for all heat measurement and power development work. Testing of thermometers and pyrometers will be an important part of the work of this Division. Power development work will include heat engines, turbines, automobile and aero-engines, jet- and rocket-propulsion engines. Among other subjects which will be dealt with in this Division are low-temperature research, cold-storage problems and refrigeration.

The optical work of the Laboratory, including standardization of optical instruments, testing of lenses and binoculars, standardization of light sources, photometry and testing of lamps will fall within the scope of the Division of Optics.

It is proposed to subdivide the Electricity Division of the Laboratory into three sections dealing with (*a*) Electrical Standards, (*b*) Electro-technics, and (*c*) X-rays and Radiology. The electro-technics section will include also high-voltage tests. Standardization of radioactive sources, radioactive substances and their radiations will be included under section (*c*).

A very important Division of the Laboratory will be that of Electronics and Sound, which will include all aspects of electronic work, including electron microscopy. Investigations on the ionosphere and troposphere, research on micro-waves and development of radar, nature of atmospherics, industrial electronics, etc., are some of the other subjects to be included in this Division. The Sound section will cover all aspects of acoustical measurements and electro-acoustics, including properties of sound-insulating materials.

The Division of Building and Housing Research will be concerned mainly with the physical aspects of building and housing research. This may include investigations on the strength of building materials, acoustics of buildings, heat- and sound-insulation of buildings. Housing in the tropics and air-conditioning are expected to form an important part of this Division's work, as research on this aspect of India's housing needs is most urgently required.

The Division of Hydraulics Research is another engineering division in which the National Physical Laboratory's work will be concerned mainly with the physical aspects of the many problems. The importance of this Division will be very great in view of the large river development schemes which the Government of India is to launch very soon.

The Division of Analytical Chemistry will undertake analytical work for all the Divisions of the Laboratory.

Standardization

A very important aspect of work which has not so far received sufficient attention in India is that of industrial standardization. But with the recent inauguration of the Indian Standards Institution, India, it is hoped, will develop its own industrial standards in accordance with its special requirements. The National Physical Laboratory, it is expected, will be frequently called upon to assist the work of standardization by providing trained personnel and facilities for investigation by technical committees of the Standards Institution. The Council of Scientific and Industrial Research, it may be noted here, has been associated actively with the setting up of the Institution and was represented at the British Commonwealth Standards Conference and the International Conference on Standardization held in London in October last.

Location of the Laboratory

The question of the location of the Laboratory for a vast country like India is a very important one. The Planning Committee examined this question with great care, and made out an overwhelming case in favour of locating the Laboratory at the headquarters of the Central Government. It was realized that in any new constitution which India may have, the importance of contact between science and State will be even greater. Delhi has, in addition, a number of scientific departments of the Government of India, and close contact between them and the National Physical Laboratory will be mutually beneficial. In New Delhi, the Laboratory will be situated on a spacious site of more than sixty-six acres in close proximity to one of India's largest centres for agricultural research.

Very careful thought has been given to the design and lay-out of buildings for the Laboratory. Air-conditioning will be carried out practically throughout the entire Laboratory, and all precautions will be taken to eliminate dust. Since the great problem in India is to exclude heat from buildings as much as possible, the main wings of the Laboratory will run east and west, which will permit the use of natural light through north-facing windows without direct sunlight coming in. Provision is being made for a large lecture theatre and several seminar rooms. In addition to the central workshops, which will be equipped with the best and latest precision machinery, the several Divisions of the Laboratory will be provided with individual workshops for their day-to-day work. Staff amenities like cafeteria, social club and recreation grounds are being provided, as the necessity of human contacts between members of the staff is being constantly kept in view. On the question of internal lay-out and choice of apparatus, we had the benefit of the advice and experience of the National Physical Laboratory, Teddington. In the Division of Metrology, where accurate control of laboratory temperature is vitally necessary, the plans have been discussed at length with the Teddington staff.

Staff and Finance

The Laboratory will be under a director, who will be assisted with nine assistant directors—one in charge of each Division of the Laboratory. Each Division will have its complement of senior and junior scientific officers and scientific assistants, and for a start a scientific staff of ninety-eight has been recommended. The director will be assisted by an administrative officer to look after the routine non-technical work, and by an assistant director to look after routine technical work.

The capital cost of the Laboratory is estimated at four million rupees (£300,000), and a recurring grant of one million rupees (£75,000) annually is recommended for the first five years.

Money for the capital costs of the Laboratory has already been made available by the Government of India, and construction of the Laboratory is commencing very shortly.

NUCLEAR DISINTEGRATIONS PRODUCED BY SLOW CHARGED PARTICLES OF SMALL MASS

By Dr. G. P. S. OCCHIALINI

AND

Dr. C. F. POWELL

H. H. Wills Physical Laboratory, University of Bristol

IN studying photographic plates exposed to the cosmic rays, we have found a number of multiple disintegrations each of which appears to have been produced by the entry of a slow charged particle into a nucleus. Mosaics of photomicrographs of three of these events are given in Figs. 1, 2 and 3. The edges of the individual photographs have not been trimmed so that the components of the mosaics can be distinguished. Three grains of a track in Fig. 1, indicated by three arrows, which were out of focus in the original negatives, have been blackened with ink, but the photographs are otherwise completely unretouched.

It will be seen from Fig. 1 that, associated with the 'star', there is one track, marked *m*, which shows frequent changes in direction. The points of scattering are most frequent near the centre of the 'star', and become progressively fewer in moving away from it along the trajectory. This behaviour suggests that the particle approached the disintegrating nucleus. The conclusion receives additional support from the observation that the number of grains per unit length of the track, which can be taken as a measure of the ionization produced by the particle, is greatest

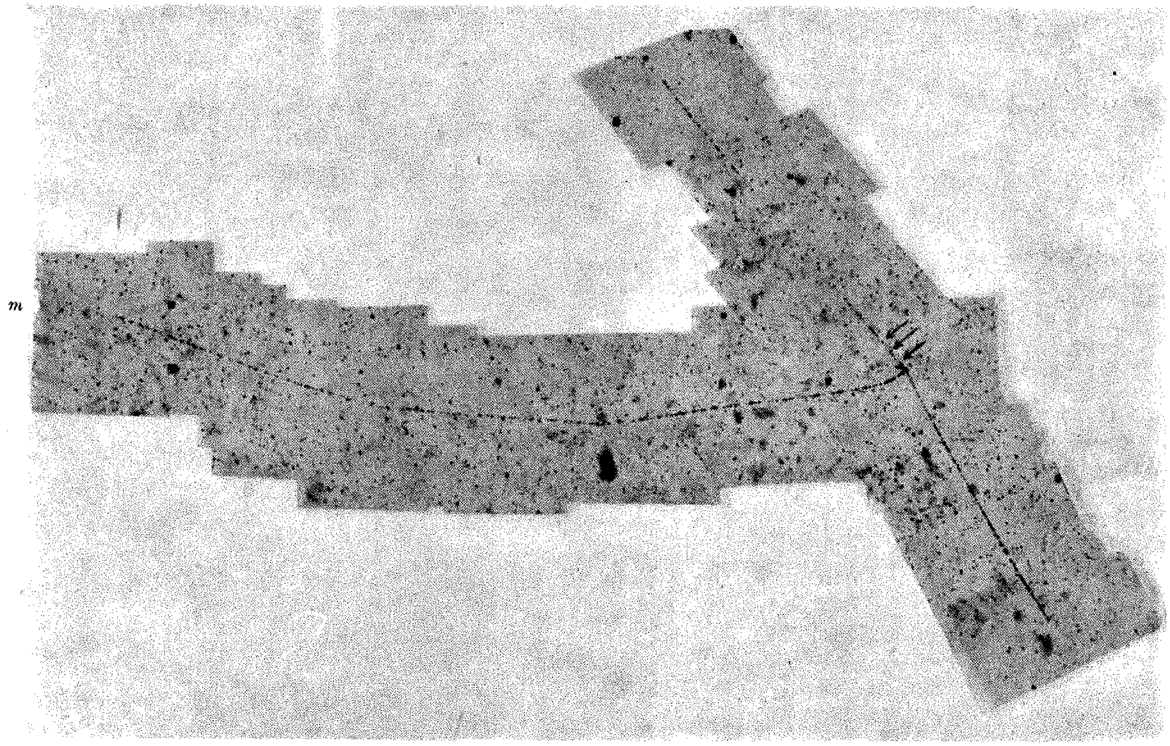

Fig. 1. COOKE × 45 'FLUORITE' OBJECTIVE, × 10 EYE-PIECE, WITH LEITZ PHOTOMICROGRAPHIC ATTACHMENT. C2 EMULSION LOADED WITH LITHIUM

The tracks of three disintegration particles can be distinguished, but only the particle of short-range remains in the emulsion

in the immediate neighbourhood of the disintegrating nucleus and becomes less as we recede from it.

We have now observed six of these events among a total of eight hundred stars. The probability, in any one case, that a charged particle, unrelated to the star, has, by chance, come to the end of its range within 1 micron of the disintegrating nucleus, is less than 1 in 10^5. We must therefore conclude that the particle entered the nucleus and produced a disintegration with the emission of heavy particles. Similar conclusions can be drawn from an inspection of the other photographs in Figs. 2 and 3.

The characteristics of the tracks which allow us to infer the direction of motion of the particles also lead to the conclusion that the particles were either at the end of their range or very near it when they entered the nucleus. **In all cases the particles enter the emulsion from the glass or at the surface.**

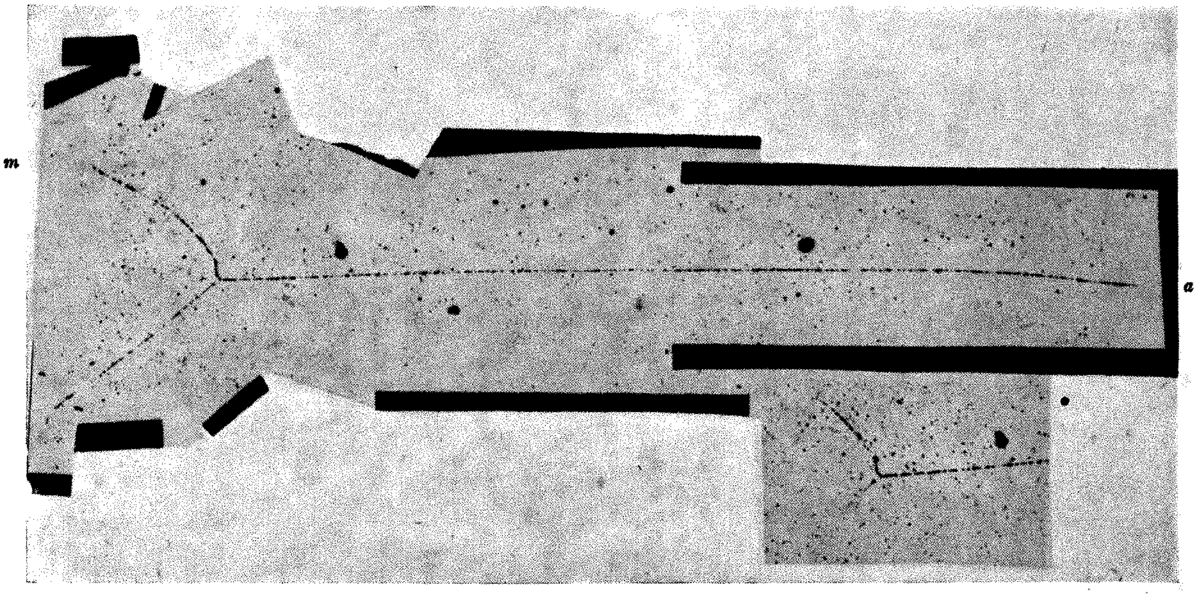

Fig. 2. COOKE × 45 'FLUORITE' OBJECTIVE, × 10 EYE-PIECE: DIRECT PHOTOGRAPHY WITH 'TELE-PANTO' PROJECTION MICROSCOPE. THE LONG TRACK *a* WHICH ENDS IN THE EMULSION IS PRODUCED BY A PARTICLE WITH A CHARGE EQUAL TO THAT OF THE PROTON. C2 EMULSION LOADED WITH LITHIUM

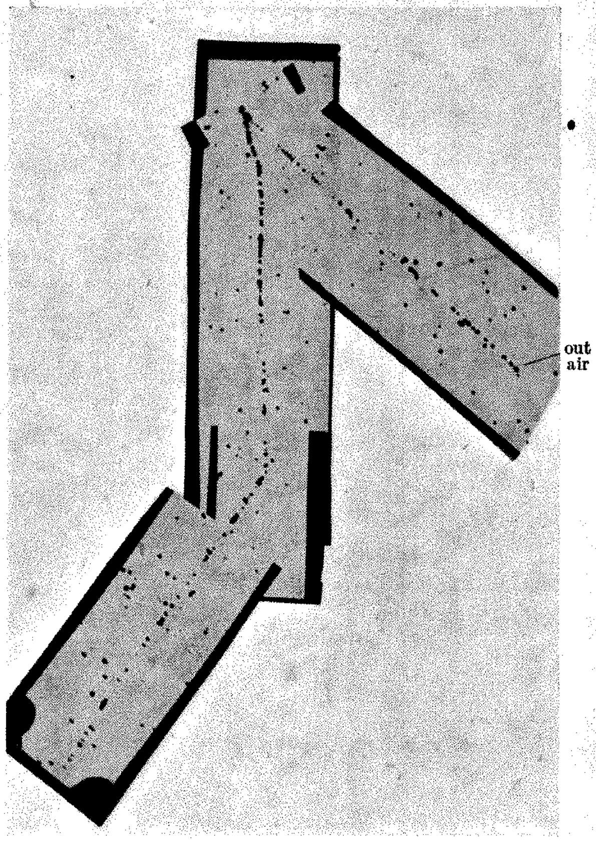

Fig. 3. COOKE × 95 'ACHROMAT' OBJECTIVE WITH × 4 EYE-PIECE. DIRECT PHOTOGRAPHS WITH PROJECTION MICROSCOPE. *C*2 EMULSION LOADED WITH BORON

Observations on the tracks of the slow particles indicated that the Coulomb scattering is more frequent than is to be expected if the particles are protons. Further, in moving along the trajectory, the increase in the grain density in the track, on approaching the centre of the star, is found to take place more rapidly than if the particles were protons. Both these qualitative observations suggested that the particles are of small mass, but more definite evidence is given by grain counts. Mr. Muirhead, in this Laboratory, has made a quantitative study of this subject, which is analogous to the problem of drop-counting in work with the expansion chamber. He has determined the variation of the grain-density along the tracks of protons in the emulsion in order to predict the distribution of grain density to be expected for particles with the same charge as a proton but with different values of the mass. A comparison of his results with the actual distribution of grains in the tracks of the particles producing the disintegration enables an estimate to be made of the mass of each particle. The values so obtained range from 100 m_e to 230 m_e, where m_e is the mass of the electron.

As in the case of drop-counting in experiments with Wilson chambers, any conclusion based on grain counting must be accepted with reserve. The latent image produced by charged particles in the 'Nuclear Research' emulsion is subject to fading, and although this effect is less marked in the types *B*2 and *C*2 than in *E*1 and *C*1, it is very serious in the usual exposures of six months duration. With this in mind we limited our exposures to six weeks; but even so the 'oldest' tracks obtained are subject to some fading. This will lead to an under-estimate of the mass of the particles, and Dr. Wassermann in this Laboratory therefore made observations by an alternative method based on measurements of the frequency of the Coulomb scattering of the particles.

Measurements on the tracks of the slow particles indicated that the number of deflexions which they suffer before being brought to rest is approximately three times greater than that of a proton of the same range. The expected frequency of scattering of particles of different mass, if they are subject only to Coulomb forces in collisions with nuclei of the atoms composing the emulsions, can be calculated. The observed frequency of scattering can thus be shown to correspond to a mass of the particle of 350 m_e ± 100.

The estimates of the mass of the particles by both methods are subject to large statistical errors due to the small number of tracks available for measurement, and they give no basis for assuming that we are dealing with particles of different types. They show conclusively, however, that the particles have a mass less than one fifth of that of a proton.

During the last few years, following the pioneer experiments of Rasetti, a great deal of evidence has been accumulated concerning the fate of mesons, which can be summarized as follows. Positive mesons decay with the emission of an electron which can be detected by delayed coincidence experiments. On the other hand, in accordance with the theoretical predictions of Araki and Tomonaga, negative mesons at the end of their range do not suffer such a β-decay but have a high probability of being captured by nuclei. This process has previously been supposed to involve excitation of the nucleus and subsequent emission of β-particles.

In view of the evidence provided by the present experiments, we believe that the particles producing the observed disintegrations are negative mesons. We consider our photographs as evidence of the fact that the entry of the particle into the nucleus produces excitation, which is followed by the emission

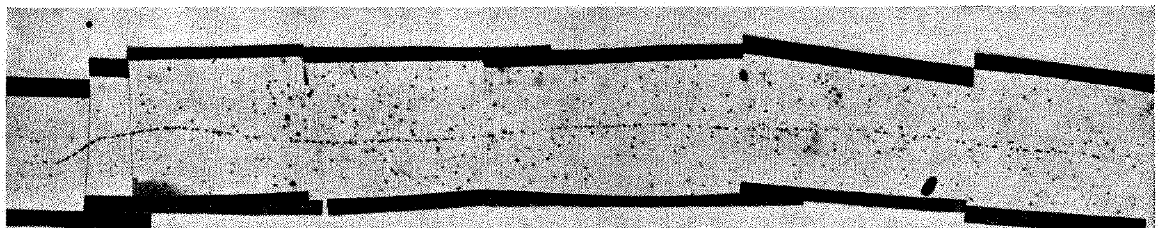

Fig. 4. COOKE × 95 'ACHROMAT' OBJECTIVE, WITH × 4 EYE-PIECE. DIRECT PHOTOGRAPHS WITH PROJECTION MICROSCOPE. UNLOADED *C*2 EMULSION

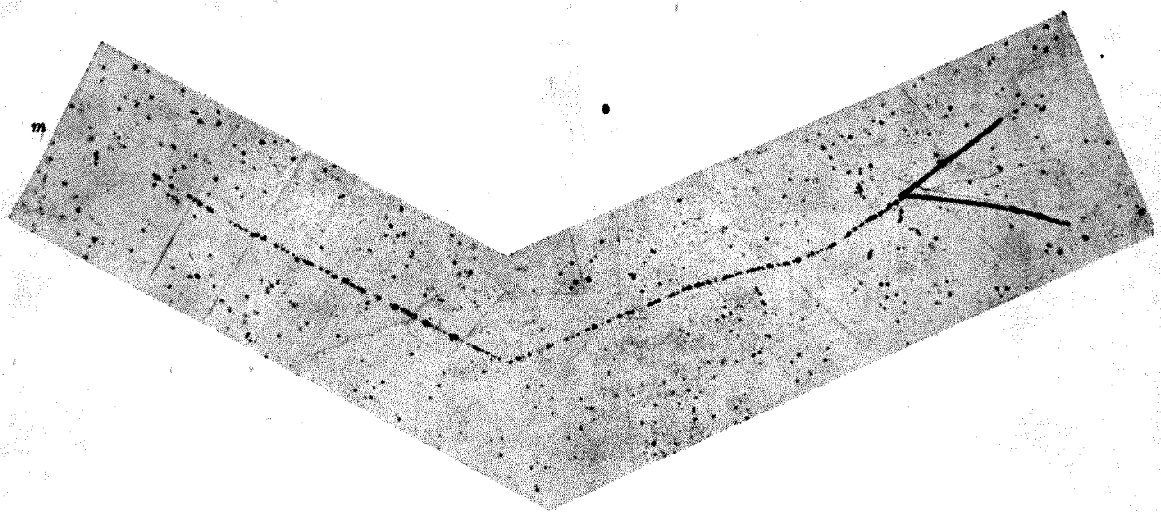

Fig. 5. Cooke × 45 'Fluorite' objective, × 4 eye-piece. Two α-particles and a particle of low range, possibly an electron, are ejected in the disintegration. *C*2 emulsion loaded with boron

of heavy particles. In support of the general picture of the fate of the positive and negative mesons, we find examples of tracks which end in the emulsion and which we identify as positive mesons, an example being shown in Fig. 4. Such tracks are distinguished by inspection, from the much larger number of disintegration protons ending in the emulsion, by the frequency of the small-angle scattering which they display, and up to the present ten examples have been found. Grain counts in every case lead to an estimate of the mass of the particle equal to or less than 230 m_e.

In addition to the determination of the mass of the particle, a second quantity of great interest is the energy released in the disintegration. In the particular disintegration shown in Fig. 1, all but one of the ejected particles pass out of the emulsion before reaching the end of their range. Further, because we regard the momentum of the particle producing the disintegration as very small, the observed directions of ejection of the disintegration particles make it necessary to assume, at least in some cases, that neutrons or other particles unrecorded by the emulsion have also been emitted. In these circumstances we cannot make a precise estimate of the total release of energy in any one of the disintegrations of this type which we have observed, and thus make a comparison of this quantity with the rest-energy of the particles producing the disintegration.

These considerations suggest that the most favourable conditions of observation for the determination of the mass of the particles will be provided in work with thick emulsions loaded with the light elements. It is possible, for example, that reactions such as those represented by the equations

$$\mathrm{Li}^{6}_{3} + m^{0}_{-1} \rightarrow \mathrm{H}^{3}_{1} + \mathrm{H}^{3}_{1} \text{ and } \mathrm{B}^{10}_{5} + m^{0}_{-1} \rightarrow \mathrm{He}^{5}_{2} + \mathrm{He}^{5}_{2}$$

may take place. Reactions of this type would be particularly easy to identify since they would lead to the ejection of two particles of equal range, moving in opposite directions from the disintegrating nucleus.

We are greatly indebted to the director of the Observatory of the Pic du Midi, Prof. J. Baillaud; to Dr. M. Hugon and Prof. Max Cosyns, who made it possible for us to obtain the exposures; to Mr. H. Muirhead and Dr. G. D. Wassermann, for making available to us the results of their work on the determination of the mass of charged particles; and to Mr. C. M. G. Lattes and Mr. P. H. Fowler for a number of discussions.

Note added in proof. Since this article was communicated, D. H. Perkins has published (*Nature*, January 25, p. 126) a photograph of an event similar to those we have discussed, and his conclusions are

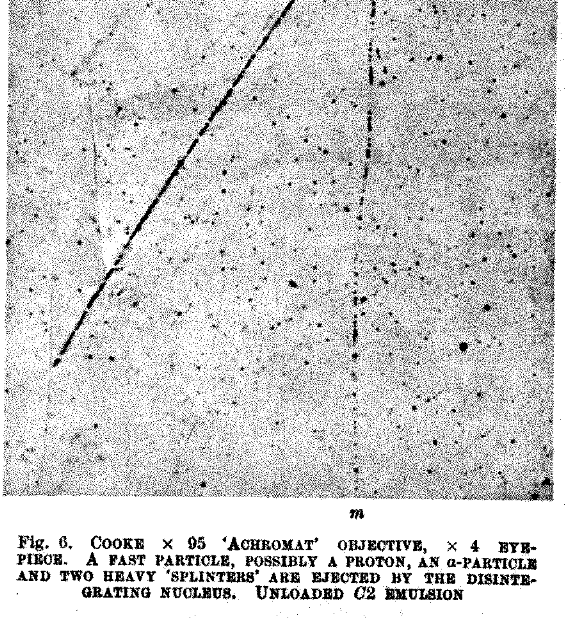

Fig. 6. Cooke × 95 'Achromat' objective, × 4 eye-piece. A fast particle, possibly a proton, an α-particle and two heavy 'splinters' are ejected by the disintegrating nucleus. Unloaded *C*2 emulsion

substantially identical with our own. The observed difference in the grain spacing of the meson tracks, in the *B*1 and *C*2 emulsions employed in the two experiments, is in good accord with expectations based on the known recording properties of the two types. The agreement between the results of observers in two different laboratories, working entirely independently with different experimental material, is a definite proof of the reliability of the photographic method in its present stage of development.

We have recently completed mosaics of two more of the six disintegrations referred to above, and reproductions of them are given in Figs. 5 and 6. We have also observed a number of disintegrations in which particles are emitted which are scattered more frequently than a proton of the same range, but which are more heavily ionizing than a meson of mass 240 m_e.

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OBITUARIES

Dr. D. Jordan Lloyd

DOROTHY JORDAN LLOYD was born in 1889, the daughter and grand-daughter of two prominent surgeons in Birmingham. It would appear natural that her early studies at Newnham College were in zoology, later physiological and then physico-chemical studies of muscle. During the First World War, her scientific pursuits were diversified, and under the auspices of the Medical Research Committee she was one of a team which studied substitutes for components of culture media for bacteria which were then in short supply. Then her brilliant short paper on the causes and prevention of ropiness in bread was most appropriate to war-time, and indicated the versatility of her mind. Under the stimulating influences of Gowland Hopkins and particularly of W. B. Hardy, she was led to the long-sustained studies of swelling in colloidal systems, which when carried over to the 'structured' proteins in animal skins gained for her the firmly established international reputation as the authority on the chemistry of leather which she held at her death on November 21, 1946. Thus, zoology in Part II of the Tripos followed by the M.A.(Cantab.), research in physiology followed by the D.Sc.(Lond.), after some interval the fellowship of the Institute of Chemistry in 1922, authorship of a standard work, "Chemistry of the Proteins" (first edit., 1926 ; second, with Ann Shore, 1938) and the directorship of the British Leather Manufacturers' Research Association (1927–46) are the signposts of an exceptional career.

The output of Dr. Jordan Lloyd's published work both in pure and applied chemistry is impressive. Returning after the First World War to her main line of research, she published her earliest papers under the auspices of the Medical Research Committee on the swelling of gelatin ; but most of her work on this subject, and indeed by far the greater part of her scientific publications, was published after she joined the staff of the British Leather Manufacturers' Research Association in 1921. Her early work followed on that of Procter by establishing the swelling curves of gelatin as affected by hydrogen ion concentration, and demonstrating the effect of salts on the swelling. Later she showed how lyotropic effects are superimposed on the swelling effects of the Gibbs-Donnan theory, and illustrated the temperature effects which that theory predicts. She emphasized the importance of the balance between osmotic pressure and cohesion in controlling the degree of swelling. This work was extended to a study of the swelling of protein fibres (collagen, silk, hair) in aqueous systems, in which not only the water uptake but also the changes in length and thickness of the fibres were followed ; these changes are of importance in giving a more detailed picture of the effects of swelling on the individual fibres and on the interwoven structure of hides. These studies of fibres showed the effect of hydrogen ion concentration on swelling, in so far as it produces salt formation by the protein, and also illustrated certain lyotropic effects. The weakening of the structure of the fibres which was observed in certain conditions was linked with the study of the molecular structure of fibrous proteins.

A number of Dr. Jordan Lloyd's papers deal with the closely related subjects of the chemical make-up of the fibrous proteins, and its bearing on their structure, water relationships and swelling properties. She carried out experiments on the amount of water in gelatin which is 'bound', that is, associated with specific groups in the protein molecules, and is to a considerable extent independent of osmotic effects. In addition to these studies of the molecular structure of fibrous proteins, she investigated the fibrous structure of hides and skins, and showed how the swelling properties of collagen fibres are affected by the sheath or network ('reticulin') which surrounds them and can be broken by strong swelling or weakened at very low and very high *p*H values.

The above work dealt with proteins in aqueous systems. In later developments Dr. Jordan Lloyd turned to a study of the effects of non-aqueous liquids (organic solvents and acids), using changes in volume, dimensions and extensibility of fibrous proteins in these liquids, to throw light on the nature of the cross-bonds which hold the protein molecules to one another, and on the orientation of these molecules in the fibres.

Her keen sense of the applicability of this mass of scientific results to the processes of the industry was coupled with a resolution and an unfailing affability towards industrialists and their technicians which was an immense advantage to the Research Association. The long series of her lectures, well attended by its members and their technical personnel, and based on the work in progress in the Association's laboratories, were symptomatic of her hold on the imaginations of those in the industry, and illustrated her wide grasp of the application of science to it. In the industry the measurement of hydrogen ion concentration and buffer index became usual, particularly in heavy-leather tanning ; the use of the microscope and the correlation of photomicrographs with composition and use of tan liquors led to control of quality in leather in general and also in its production for special purposes—a control not hitherto attained ; the disposition of the tanned fibres in leather is now related to its various measurable physical properties, and hence to quality and serviceability—such have been developed largely by her leadership and enthusiasm, which have contributed much to the gradual change of leather production from a chancy industrial art to a sequence of processes scientifically controlled.

Miss Jordan Lloyd was perhaps unique among the scientific women of her time—a vigorous and vivacious leader of her mixed team both in triumph and tribulation (for her laboratories were twice wrecked in the 'blitz' on Bermondsey); a clear thinker and good speaker with a constructive mind; a manager with ability to delegate; a research worker herself who displayed an arresting interest in the investigations of many others; and with a demeanour and practical outlook in the tanneries which appealed to the employers and their technicians. She can have perhaps no more fitting epitaph—and one possibly no more welcome to her—than the impressive volumes now appearing which describe the results of twenty-five years of research for the British leather industry by the British Leather Manufacturers' Research Association under her inspiring leadership.

ROBERT H. PICKARD

WE regret to announce the following deaths:

Dr. F. F. Blackman, F.R.S., formerly reader in botany in the University of Cambridge, on January 30, aged eighty.

Prof. James H. Leuba, emeritus professor of psychology at Bryn Mawr College, Pennsylvania, on December 8, aged seventy-eight.

Prof. L. W. Lyde, since 1928 emeritus professor of geography in the University of London, on January 24, aged eighty-three.

Dr. F. B. Mumford, emeritus dean of the College of Agriculture, University of Missouri, on November 12, aged seventy-eight.

NEWS and VIEWS

Advisory Council on Scientific Policy: Sir Henry Tizard, K.C.B., F.R.S.

MR. ARTHUR GREENWOOD, Lord Privy Seal, has announced in a Parliamentary written reply that it has been decided, in addition to the establishment of the Defence Research Policy Committee, to set up on the civil side an Advisory Council on Scientific Policy to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy. The chairman will be Sir Henry Tizard, who is also chairman of the Defence Committee, and the staffs of the two bodies will work in close association. The Council will include the heads of the principal Government scientific organisations and a number of scientific workers from outside the Government service. The former Scientific Advisory Committee will now cease to exist. The latter, it will be recalled, was set up in October 1940, and consisted of the president and secretaries of the Royal Society, and the secretaries of the chief Government research departments, under the chairmanship of Lord Hankey. In the new Advisory Council the choice of membership has been somewhat extended, but presumably its functions will be roughly the same.

As chairman of the Defence Research Policy Committee and also of the Advisory Council on Scientific Policy, Sir Henry Tizard will occupy a unique position in the scientific life of Great Britain. For this he is admirably fitted. Apart from a distinguished academic record which gave promise of exceptional ability, his work during and after the First World War in aeronautical research and his influence on British aircraft development made him well known in scientific and engineering circles. A short period (1927–29) as permanent secretary of the Department of Scientific and Industrial Research when that Department was becoming established gave him first-hand knowledge of State administrative machinery. From 1929 until 1942 he was rector of the Imperial College of Science and Technology, London, and since 1942 he has been president of Magdalen College, Oxford. Thus he has unusual experience in scientific, engineering and administrative fields such as few can boast, which makes the choice of Sir Henry for the chairmanship of the new bodies for the organisation of defence and scientific research a particularly appropriate one.

Thomas Alva Edison (1847–1931)

THOMAS ALVA EDISON was born in the then village of Milan, Ohio, on February 11, 1847, and died at West Orange, New Jersey, on October 18, 1931, at the age of eighty-four. Many years before Edison's death, Sir Richard Gregory wrote in his "Discovery, or the Spirit and Service of Science", "Thomas A. Edison is the embodiment of the method of specialised research with a practical purpose. By quickness of perception, fertility of resource, and persistent trial of everything until the best means of achieving his end has been found, he has become the leading inventor in the world." It is not far short of seventy years since the journalists of America raised him to the status of a sort of national hero. His first triumph was achieved when as a boy of fifteen he set up, printed and published a newspaper on a running train. By twenty-one he had secured the first of his thousands of patents and resigned an appointment with a telegraph company in order to bring out his inventions. From that time, patent followed patent, and in 1876 he founded the famous laboratory at Menlo Park, New Jersey, where he employed both men of science and men of skill to carry out his ideas. In quick succession came a series of innovations in telegraphy and telephony, the phonograph, photography, and in all that appertained to the generation, distribution and utilization of electricity. All that he did has to be studied with a knowledge of what had been and was being done by others, for he always made the fullest use of contemporary discoveries.

It was largely through the exhibition of Edison's 'Jumbo' dynamos and the incandescent lamp, in the United States and at the Paris Exhibition, that his reputation became world-wide. From his work on these things sprang the plans for the Pearl Street Electric Power Station in New York and the similar station at Holborn Viaduct, London, both of which were put into operation in 1882 for lighting the neighbouring streets and business premises. Some four hundred lamps in the telegraph operating room in the General Post Office, Newgate Street, were supplied with current from Holborn Circus. Edison was only thirty-five at this time, but he was probably at the height of his powers. His work and list of patents taken out afterwards, however, is impressive. In fertility of ideas he was perhaps only rivalled by his countryman Hiram Maxim. In later life he was accorded many honours, but he probably appreciated as much as any the award to him in 1892 of the Albert Medal by the Royal Society of Arts. Only one American, Eads, the great bridge builder, had received it previously. Of Dutch descent on his father's side, Edison came of a long-lived family, and he could tire out any of his staff. His mother, to whom his debt was great, was of Canadian-Scottish descent. He himself was twice married and had six children. The Menlo Park laboratory has now been removed to Mr. Henry Ford's Industrial Museum at Dearborn, Michigan; it is a worthy memorial.

New York Academy of Medicine: Centenary Celebrations

THE first meeting of the New York Academy of Medicine was held on January 6, 1847, when the founders dedicated themselves to the establishment of an institution for the improvement of medical education, the advancement of the public health, the elimination of quackery and malpractice and the instruction of the public on matters of health and hygiene. Centenary celebrations will begin on March 6, with an assembly of the fellowship and the friends of the Academy, when the centennial discourse will be delivered by Prof. John A. Ryle, head of the Institute of Social Medicine at Oxford, who will speak on "Social Pathology and the New Era in Medicine". Following this meeting, a series of activities in the Academy building have been planned which will continue throughout March and April. Each of the eleven sections of the Academy will celebrate the centennial with a dinner of its own members, followed by a meeting in which eminent authorities in the specialty will participate. Each of the Academy's standing committees has arranged for a three-day conference, dealing with post-graduate medical education, public health, social medicine, hospitals and medical libraries respectively.

Various affiliated clinical and scientific societies such as the Harvey Society, the Society for Experimental Biology and Medicine, the New York Academy of Sciences and the New York Chapter of the American Chemical Society have accepted invitations to hold meetings in the Academy building during the period of the celebration. A historical exhibit of the Academy and its role in medical progress over the past one hundred years is being assembled and will be on view in the Academy throughout March and April. An exhibit is also being assembled in collaboration with the New York City Planning Commission and hospital authorities dealing with the history of the older municipal and voluntary hospitals of the city, at which plans for their post-war development will be shown. Special public exhibits on medical and historical subjects are being arranged at the Metropolitan Museum of Art, the New York Public Library, the New York Historical Society, the Museum of the City of New York and at private art galleries which possess famous prints, collections and other *memorabilia* on the medicine of a hundred years ago. Dr. George Baehr, president of the Academy, will broadcast an address on "A Hundred Years of Medical Progress".

Atomic Research in India

IT is reported (*J. Sci. Ind. Res., India*, **5**, 90; Aug. 1946) that the Atomic Research Committee of the Council of Scientific and Industrial Research, India, has recommended an intensive geological and physico-chemical survey of the thorium-bearing minerals in Travancore, and set up a sub-committee to draw up proposals for a similar survey of uranium-bearing minerals in India. The Committee considers that atomic research should be given first priority and encouraged by the Government of India on a large scale. However, as it is likely that only small sums will be available for the purpose, it will be necessary to concentrate research at one centre in the country. The centre recommended is the Tata Institute of Fundamental Research in Bombay, where a 300 MeV. betatron, with a team of ten workers to operate it, is to be established. Grants, to Prof. M. N. Saha for operational expenses of a cyclotron, and to Prof. D. M. Bose for research on the trans-uranic elements, were also recommended by the Committee.

A New Polarizing Light-Filter

DR. BRUCE BILLINGS, of the Polaroid Research Laboratory (Polaroid Corporation, Cambridge 39, Mass.), has recently given to the American Astronomical Society and the American Association for the Advancement of Science an account of a new type of light filter, making use of the familiar process of building up a filter by the use of crystal plates. Dr. Billings has varied the method by using plates the optical characteristics of which change under the influence of an electric field. This admits of much more rapid and easily controlled changes in the wave-lengths transmitted through the filter than was possible with earlier types. No details are given in the account available as to the narrowness of the band of transmitted light; but it is claimed that it allows for changes in the velocity in the line of sight in prominence streamers so as to give a complete record of the motions of parts of a prominence from a series of pictures taken at different wave-lengths in rapid succession. This promises a marked advance in our knowledge of the three-dimensional structure and whirling motions in prominences, just when they are becoming of increased interest to the student of solar and terrestrial phenomena. Further details will be awaited with interest.

Kew Bulletin

IT will be welcome news to botanical systematists that publication of the *Kew Bulletin* has been resumed after a lapse of nearly five years. The last number to appear was No. 3, 1941, which was issued in March 1942, and publication was thereafter suspended until No. 1, 1946, which has just been issued (London: H.M. Stationery Office, Dec. 1946, 2*s*. 6*d*.). It contains a continuation of the additions to the flora of Borneo and other Malay Islands, a part of which was published in 1940, a key to the Carices of Malaysia and Polynesia, notes on some species of the genus *Cryptolepis*, and a description and figure of a new species of *Arisœma* as principal contents.

Spiral Cracks in Glass Tubing

W. P. THISTLETHWAITE, Merchant Venturers' Technical College, Bristol, writes: "A few days after the appearance in *Nature* of October 19 (p. 582) of a letter on this subject, a student brought to me a test-tube exhibiting a perfect spiral crack. The tube was new but notched at the mouth, and was being used to heat a mixture of sand and ammonium chloride. Apparently the crack appeared immediately on contact with a bunsen flame; it originated at the notch in the lip of the tube. That the crack was complete and not merely superficial was shown by the concertina-like behaviour of the tube when pulled."

Summer School in Theoretical Physics and Conference on Mechanical Properties of Solids

The University of Bristol, in co-operation with the Institute of Physics, is arranging a Summer School in theoretical physics, with particular application to cohesive forces in metals and mechanical properties of solids, to take place during July 2–5. Lectures will be given by Prof. N. M. Mott, Dr. H. Fröhlich, and other members of the staff of the Laboratory. The course will be followed by a Conference on the Mechanical Properties of Solids (July 7–9), at which papers on the experimental and theoretical aspects of the subject will be given by research workers from Great Britain and abroad. The Summer School is intended mainly for members of staffs of Government and industrial research laboratories who wish to familiarize themselves with the theoretical aspects of subjects on which they have carried out experimental investigations. Subjects to be treated will include: cohesive forces in metals and elements of the zone theory; properties of Taylor dislocations; the Griffith crack theory; deformation of non-metals and theories of viscosity of liquids. The Conference will deal with the same subjects, and the lectures in the Summer School will be designed to provide the theoretical background for the discussions of the Conference. There will be no fee for the Conference, and it is not envisaged that everyone attending the Conference will wish to attend the Summer School. Accommodation will be reserved for a limited number at the University hall of residence, Wills Hall, Stoke Bishop, Bristol, 9. Particulars as to admission and as to the fees payable for the Summer School can be obtained either from the Secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1, or from the Director of the Department of Adult Education, University, Bristol

Symposium on Coal, Petroleum and Their Newer Derivatives

The Scottish Sections of the Royal Institute of Chemistry have arranged a symposium on "Coal, Petroleum and Their Newer Derivatives" to be held at St. Andrews during July 7–12. The conveners have received much help from the Principal of the University of St. Andrews, and the staff of the Department of Chemistry of the University. The symposium is designed to give industrial scientists and others a comprehensive idea of developments which have been made in recent years in heavy organic chemistry. The first part of the symposium will deal with the raw materials and their sources, the second part with chemical syntheses, and the third part with physical-chemical problems of polymerization, etc. Both academic and industrial aspects of the problem will be discussed. Each lecture will be followed by a short interval for discussion, and on the last day there will be a general discussion and the position will be reviewed. Those attending the symposium may be accommodated in the students' residences. Arrangements have been made for accommodation from arrival on the evening of July 5, until the morning of July 12. Bookings will commence on March 1, and applications should be forwarded to the Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

Royal Microscopical Society: Officers

The following have been elected officers of the Royal Microscopical Society: *President*: Dr. J. R. Ludford; *Vice-Presidents*: Dr. G. M. Findlay, Mr. C. F. Hill, Dr. James A. Murray, Dr. T. E. Wallis; *Hon. Treasurer*: Mr. S. R. Wycherley; *Hon. Secretaries*: Mr. F. C. Grigg, Dr. H. Moore; *Ordinary Members of Council*: Mr. F. D. Armitage, Dr. L. P. Clarke, Dr. F. Greenshields, Major Maxwell Knight, Mr. Chetwynd Palmer, Mr. R. Ross, Mr. D. J. Scourfield, Mr. J. Smiles, Mr. H. Gilbertson Smith, Mr. E. Wilfred Taylor, Dr. C. Tierney, Mr. J. M. Watson; *Hon. Editor*: Dr. G. M. Findlay; *Hon. Curator of Instruments*: Dr. C. Tierney; *Hon. Curator of Slides*: Mr. N. Ingram Hendey; *Hon. Librarian*: Mr. R. Ross.

Royal Meteorological Society: Officers

The following have been elected officers of the Royal Meteorological Society: *President*, Dr. G. M. B. Dobson; *Vice-Presidents*, W. Dunbar, G. Manley, Sir Charles Normand, J. F. Shipley; *Treasurer*, W. M. Witchell; *Secretaries*, E. L. Hawke, Wing-Comdr. R. M. Poulter; *Scottish Secretary*, A. J. Drummond; *Foreign Secretary*, L. C. W. Bonacina; *Editor*, Dr. R. C. Sutcliffe; *Council*, A. C. Best, G. S. Callendar, J. S. Forrest, Capt. L. G. Garbett, Major H. C. Gunton, W. G. Kendrew, I. T. D. Kirkpatrick, Dr. A. R. Meetham, Dr. F. J. Scrase, P. A. Sheppard, A. E. Slater, Dr. T. W. Wormell.

Announcements

Princess Elizabeth has been elected a Royal Fellow of the Royal Society.

Prof. A. A. Hall, Zaharoff professor of aviation and head of the Department of Aeronautics, Imperial College of Science and Technology, has been appointed a member of the Air Safety Board.

Dr. Franz Weidenreich, of the American Museum of Natural History, is the first recipient of the newly created Viking Fund Medal and Prize in Physical Anthropology, for his many contributions to palæo-anthropology, and especially for his very important recent studies on fossil man in China and Java. Dr. Weidenreich was presented with the Viking Fund Prize of 1,000 dollars at the annual meeting of the American Association of Physical Anthropologists on December 28.

Mr. C. L. Bird, lecturer in dyeing in the University of Leeds, has been appointed editor of the *Journal of the Society of Dyers and Colourists* in succession to the late Prof. F. M. Rowe.

To commemorate the centenary of the Chemical Society, which was founded at a meeting on February 23, 1841, in the rooms of the Society of Arts, a special joint meeting of the two Societies will be held at the Royal Society of Arts, John Adam Street, Adelphi, W.C.2, on February 19 at 5 p.m. Viscount Bennett, president of the Royal Society of Arts, will preside, and Sir Harold Hartley will speak on "A Century of Chemistry". Tickets of admission will be available on request to the Secretary, Royal Society of Arts.

Owing to continued public interest, the "March of Time" film entitled "Atomic Power" will continue to be shown at the Science Museum until February 23, by courtesy of Messrs. 20th Century Fox Film Co., Ltd. It is being shown on weekdays at 2.30 p.m., and on Sundays at 3.15 and 4.15 p.m. Admission is free.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nature of Myosin

We have been led to regard 'myosin' as a rather involved system of substances, in spite of the fact that it readily crystallizes and behaves as a homogeneous substance on recrystallization. It consists of a skeleton to which are adsorbed a number of protein-like substances. The skeleton, and also the adsorbed proteins, are, in themselves, inactive, their system being only capable of enzymic reactions and of contraction. The adsorbed substances all seem to belong to the same remarkable group of substances, characterized, in impure condition, by their stability in 0·1 *n* hydrochloric acid at 100° (15 min.). They can be treated with *n* hydrochloric acid or precipitated by trichloro-acetic acid without loss. These substances will be called 'protins', to distinguish them from other proteins. H. M. Kalckar was the first to describe, in muscle, an acid- and heat-stable protein, his 'myokinase'.

So far, we have been able to recognize the existence of 'protins', involved in the following reactions of 'myosin': (1) 'ATP-*P*-protin', involved in the dephosphorylation of adenosine-triphosphate (Banga). (2) 'ATP-*c*-protin', involved in the contraction of myosin, linked to fibrous actin, in presence of adenosine-triphosphate (Guba). (3) 'ATP-*N*-protin', involved in the deamination of adenosine-triphosphate by myosin (Banga). (4) 'ADP-*P*-protin': dephosphorylation of adenosine-diphosphate (Banga). (5) 'ADP-*N*-protin': deamination of adenosine-diphosphate (Banga). (6) 'ADP-*c*-protin'; contraction of myosin, linked to actin, in presence of adenosine-diphosphate (Guba).

(1) and (2) are probably identical. (4) and (5) may be identical since deamination of adenosine-diphosphate always goes *pari passu* with dephosphorylation (Banga). If (4) and (5) are identical, the substance cannot be identical with (6), which is a chromoproteid and can be inactivated by oxidation and reactivated by reduction (Guba); (4) and (5) can be inactivated by oxidation but cannot be reactivated by reduction. (6) may be identical with either (4) or (5) if they are different substances. (3) and (5) are definitely different, and so are (1) and (3).

The 'protins' can be found in free condition in a watery muscle-extract and can be readsorbed to the skeletal substance of myosin, forming an active complex again. The 'protins' involved in the reactions with adenosine-diphosphate can be removed relatively easily from myosin if the latter is poor in actin: it suffices to suspend the myosin over-night in a bigger volume of 0·025 *m* potassium chloride at 0°. The 'protins' involved in the reactions with adenosine-diphosphate can be removed only under special conditions. In this case the myosin must be entirely free of actin. In order to inactivate her myosin for the phosphatase test with adenosine-triphosphate, Banga suspended it (1 mgm. per ml.) in 0·5 *m* potassium chloride, containing 0·2 *m* acetate-buffer of *p*H 6, and stored it for two days at room temperature. Guba suspended his myosin in big volumes of 0·025 *m* potassium chloride of *p*H 6 for 5–36 hours at 0°, depriving it of contractility in presence of adenosine-triphosphate. One of his preparations, which was inactive in the contraction test, was still 50 per cent active as phosphatase. As the 'protins' are washed off, the skeletal substance becomes more and more insoluble and seems to denature. Hydrogen ions favour the dissociation of skeletal substance and 'protins' but at the same time tend to denature, the limits of both processes lying very close together. If the enzymic activity was reduced by more than 85 per cent, Banga was unable to obtain reactivation. On readsorption of 'protin' to the skeletal substance, the solubility of this latter increases.

The skeletal substance of myosin seems to be distinguished by a high adsorption power not only towards 'protins' but also towards different anions, cations, adenosine-triphosphate and other substances as well. Only the full system, containing the skeletal substance, with 'protins', potassium, magnesium, adenosine-triphosphate, possibly other anions and a special cerebroside (Guba and Szent-Györgyi) adsorbed, is active as contractile matter. This system is capable of contraction if linked to fibrous actin.

The conditions described may seem rather extraordinary. It must be remembered, however, that myosin is the first structural protein, analysed to this extent, performing a basic biological function and having two distinct states, characterized by a difference in free energy.

This research was sponsored by the Josiah Macy Jr. Foundation, New York.

I. Banga
F. Guba
A. Szent-Györgyi

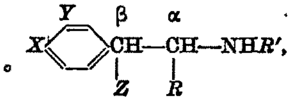
Institute of Biochemistry,
University of Budapest.
Dec. 28.

Molecular Asymmetry and Biological Activity

Easson and Stedman[1] have advanced the theory that the differences in biological activity between optical isomers should be considered in exactly the same light as the variations in potency shown by structural isomers. They pointed out that only one optical isomer can come into close contact with the specific receptors, and suggested that the weaker enantiomorph behaves as if one of the active groups is not present at all. In adrenaline, the active groups are: the amino group, the benzene ring with its phenolic hydroxyls, and the alcoholic hydroxyl group. By this view, *l*-adrenaline can come into complete contact with the receptors, and the weaker enantiomorph, *d*-adrenaline, cannot. Desoxyadrenaline (epinine) should, therefore, have the same activity as *d*-adrenaline, except in so far as the activity is modified by changes in physical properties by the presence of the alcoholic hydroxyl group. Easson and Stedman presented evidence that epinine and *d*-adrenaline do, in fact, have the same effect on blood pressure, and they also found support for the concept in drugs of the miotine type. If the theory is generally true, similar considerations should apply among compounds related to adrenaline: compounds containing a lævo-rotatory β-carbon atom should be the more active, and, with the above reservations regarding physical properties, the activity of the dextro-rotatory enantiomorphs should approximate to that of the desoxy-derivatives.

The theory received considerable support from Schaumann[2], who found that *d*-corbasil (dihydroxynorephedrine) has approximately the same activity as desoxycorbasil (dihydroxyphenylisopropylamine), but that *l*-corbasil is about 160 times as active. On the other hand, Alles and Knoefel[3] found that phenylethylamine is much more active than *d*-phenylethanolamine when tested in dogs and cats. Other differences in biological activity were also found, and they concluded that these two compounds are not at all related in their activities as required by the theory of Easson and Stedman.

To examine the theory further, I have collected in the table below the published results on the pressor activities of optical isomers of compounds of the type



where X is OH or H, Y is OH or H, Z is OH or H, R is CH_3 or H, and R' is CH_3 or H. The figures quoted for *d*-adrenaline and for epinine have the advantage over those quoted by Easson and Stedman in that they were both obtained in the same laboratory[4]. Taken in conjunction with the other published figures comparing the activity of these compounds[4,5], it is not unlikely that epinine is significantly more active than *d*-adrenaline. Although strictly comparable results are not available, desoxysynephrine appears to be much more active than *d*-synephrine[6,7].

The problem is rather more complex in compounds related to ephedrine, which have two asymmetric carbon atoms. It has been customary, with compounds of this nature, to compare each isomer with its enantiomorph (that is, *l*-ephedrine with *d*-ephedrine); but this involves a reversal in the configuration of both the asymmetric carbon atoms. For the present purpose, it is more logical to compare the three compounds having identical configuration on the α-carbon atom, but differing in configuration on the β-carbon atom; that is, to compare *l*-ephedrine with *d*-ψ-ephedrine and *d*-desoxyephedrine, and to compare *l*-ψ-ephedrine with *d*-ephedrine and *l*-desoxyephedrine. The former group has a dextrorotatory α-carbon atom, the latter a lævo-rotatory α-carbon atom[5]. In this connexion it is significant that *l*-ephedrine and *d*-ψ-ephedrine are much more powerful mydriatics than *l*-ψ-ephedrine and *d*-ephedrine. Furthermore, the latter two compounds are inactive as pressors in man, *per os*, under conditions in which the former two compounds are active[8]. These results must, therefore, be associated with the configuration of the α-carbon atom.

MOLECULAR ASYMMETRY AND PRESSOR ACTIVITY

Common name	Formula					Optical rotation		Pressor activity relative to *l*-adrenaline
	X	Y	Z	R	R'	βC	αC	
l-Synephrine	OH	H	OH	H	CH_3	—	Nil	1/58[6]
d-Synephrine	OH	H	OH	H	CH_3	+	Nil	1/3480[6]
Desoxysynephrine	OH	H	H	H	CH_3	Nil	Nil	1/108[7]
l-Adrenaline	OH	OH	OH	H	CH_3	—	Nil	1[4]
d-Adrenaline	OH	OH	OH	H	CH_3	+	Nil	1/20[4]
Epinine	OH	OH	H	H	CH_3	Nil	Nil	1/12[4]
l-Propadrine*	H	H	OH	CH_3	H	—	+	1/317[5]
d-ψ-Propadrine*	H	H	OH	CH_3	H	+	+	1/1900[5]
d-Benzedrine*	H	H	H	CH_3	H	Nil	+	1/270[5]
l-ψ-Propadrine*	H	H	OH	CH_3	H	—	—	1/1700[5]
d-Propadrine*	H	H	OH	CH_3	H	+	—	1/473[5]
l-Benzedrine*	H	H	H	CH_3	H	Nil	—	1/282[5]
l-Ephedrine	H	H	OH	CH_3	CH_3	—	+	1/142[5]
d-ψ-Ephedrine	H	H	OH	CH_3	CH_3	+	+	1/735[5]
d-Desoxyephedrine	H	H	H	CH_3	CH_3	Nil	+	1/787[5]
l-ψ-Ephedrine	H	H	OH	CH_3	CH_3	—	—	1/5000[5]
d-Ephedrine	H	H	OH	CH_3	CH_3	+	—	1/420[5]
l-Desoxyephedrine	H	H	H	CH_3	CH_3	Nil	—	1/555[5]

* Tested as *l*-mandelates.

Examination of the figures in the table shows that, if the theory of Easson and Stedman is correct, then the physical properties of the molecule must play a profound part in the biological activity; for the results, on the whole, are in poor agreement with the theory. The most abnormal results are given by the ψ-ephedrines and ψ-propadrines (norephedrines), which are very much less active than expected. It appears that for enhanced activity among compounds of this type, the optical rotation of the two asymmetric carbon atoms should be of opposite sign. This may be compared with the biological results obtained with quinine and related compounds, for Neeman[9] has pointed out that, for enhanced antimalarial activity, the optical rotation of C–8 and C–9 of the quinine derivative should be of the same sign.

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THE hypothesis which Easson and I formulated to explain the quantitative differences between the physiological activities of optical enantiomorphs is simple and apparently without an alternative; its examination, moreover, is likely to throw light on obscure features in the general relationship, which undoubtedly exists, between chemical structure and biological activity. I therefore welcome attempts to examine further material with the object of testing its validity more extensively than has hitherto been possible.

The data which Dr. Badger has collected from the literature are, however, at first sight somewhat unsuitable for this purpose; the compounds involved possess, as compared with adrenaline, only small pressor activities; and the interpretation of the data is complicated by the presence in most of the compounds considered of a second asymmetric carbon atom. Nevertheless, despite these disadvantages, there is one striking regularity to be observed in the results: in each of the triads in which Dr. Badger has arranged the compounds, the abolition of the asymmetry of the β-carbon atom by the replacement of the alcoholic hydroxyl by hydrogen results in the production of a compound which has a pressor activity of the same order of magnitude as that of one of the β-hydroxy compounds and widely different from that of the other. This result is, in my opinion, in general accord with the hypothesis in question.

That Dr. Badger has not observed this regularity, or has not noted its significance, but, on the contrary, considers the data to be at variance with the hypothesis, is, no doubt, due to his too limited interpretation of the original hypothesis. As Easson and I pointed out at the time it was formulated, in order to apply the hypothesis to a particular drug, it is necessary to decide which of the four groups linked to the asymmetric carbon atom are concerned with the attachment of the drug molecule to its receptor. In the case of adrenaline, a decision presents no difficulty. But because the alcoholic hydroxyl group in *l*-adrenaline has a very potent influence in determining the large pressor activity of the molecule as a whole, and can therefore be assumed to assist in attaching it to the receptor, it does not follow that the same effect will be produced by a hydroxyl group similarly situated in compounds which, while they may be structurally related to adrenaline, lack certain of its other potent groups and contain substituents which are absent from adrenaline. This is particularly the case when the activities of the compounds range from 1/58 to 1/5,000 of that of *l*-adrenaline and are thus considerably less active than even epinine, which possesses no alcoholic hydroxyl. To ascertain the effect of the hydroxyl on the union between drug and receptor, it is necessary to consider the change in pressor activity when it is replaced by hydrogen.

From the figures quoted by Dr. Badger, it is evident that with *l*-synephrine and *l*-propadrine there is little change, and it must therefore be assumed that in these cases the hydroxyl plays no part in the attachment of the drug and is therefore oriented away from the receptor. On the other hand, the corresponding hydroxy compounds with dextrorotatory β-carbon atoms are far less potent, suggesting that here the hydroxyl, now directed towards the receptor, creates an obstacle to the complete attachment of the drug to it. The triad containing *l*-ephedrine behaves like the adrenaline triad and need not, therefore, be considered further. There remain, however, the *l*-ψ-propadrine and *l*-ψ-ephedrine triads. These differ from the *l*-propadrine and *l*-ephedrine ones in containing a lævorotatory α-carbon atom, which is no doubt responsible for their different behaviour. With these last triads, substitution of the β-hydroxyl by hydrogen causes a large increase in pressor activity when the β-carbon is lævorotatory and practically no change when it is dextrorotatory. With the former, the hydroxyl is evidently oriented in the direction of the receptor, thus creating an obstacle to intimate union between the two; with the latter, it is directed away from the receptor and hence plays a passive part in the activity of the drug.

Since Dr. Badger has referred to the work of Alles and Knoefel on phenethylamine and its β-hydroxy compounds, I should like finally to point out that he does not mention the result, obtained by these authors, that "phenethylamine and *d*-β-hydroxyphenethylamine are rather similar in their pressor effects in the rabbit in certain dosage and both are less active than *l*-β-hydroxyphenethylamine". Evidently, in rabbits at the particular dosage involved, these drugs do follow the hypothesis in much the same way as does adrenaline. The reason why the same relationship is not apparent with higher doses, or when cats and dogs are used, is no doubt connected with Alles and Knoefel's finding that the drugs are in these circumstances also active towards other receptors. If different active groups are involved in the union with these receptors, it is quite clear that no regularity is then to be expected.

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Biosynthesis of the Belladonna Alkaloids

DR. W. O. JAMES, in his interesting paper on "Biosynthesis of the Belladonna Alkaloids"[1], states that the embryos and endosperms of the resting seeds of *Atropa* and *Datura* are without alkaloids, but that the latter appear at an early stage of germination.

Dr. Henry, in his "Plant Alkaloids", gives the following average total alkaloid figures for seeds:

Atropa belladonna	0·83 per cent
Datura metel	0·23 to 0·50 per cent
Datura stramonium	0·20 to 0·48 per cent

The results of numerous analyses have, in my experience, confirmed these figures. Since the embryo and endosperm constitute a large part of the bulk of the seed it would be interesting if Dr. James would indicate which part of the seed structure does in fact contain the alkaloids known to be present.

It may be of interest to record here that the juice of the ripe belladonna berry does not contain any alkaloids, and has a pleasant, sweetish but somewhat insipid taste.

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[1] *Nature*, **158**, 654 (1946).

A NUMBER of independent investigators have examined the distribution of alkaloids in the tissues of *Atropa*[1,2,3] and *Datura*[1,2,4,5] seeds. They have used a variety of precipitants; but principally iodine in potassium iodide, which, with the technique developed by Errera[6] and his school, is the most dependable for revealing the whereabouts of alkaloids by precipitation within tissues. These workers are agreed that the belladonna and thorn-apple alkaloids are restricted in the ripe seed to the peripheral layers, that is, to the testa itself and especially to a thin layer of cells lying between the testa and the endosperm; probably a perisperm derived from the nucellus. This curious distribution is also found in the seeds of *Hyoscyamus*[1,4]. It has been confirmed in my own laboratory for those of belladonna[3]. Barth[5], examining *Datura stramonium* seeds that were not quite ripe, thought that there might be a little alkaloid also in the embryo and endosperm. Other investigators examining seeds that were fully ripe found none in either of these parts.

At the outset of germination, therefore, both endosperm and embryo are devoid of alkaloids, and Clautriau[1] obtained a completely alkaloid-free germination of *Datura stramonium* seeds by removal of the surface tissues. Normally, these alkaloids diminish[5], possibly on account of leaching out as salts from their exposed position in dead peripheral cells[7,8]. The alkaloids of the seedling plants appear first at the root apices[1,9], and removal of the outer seed tissues does not cause any abnormalities in germination[1]. The formation of quantities sufficient for micro-extraction has been recorded for belladonna only after three weeks; for thorn-apple after eighteen days and for henbane after seven weeks[10]. By a technique recently described[9], I have been able to observe alkaloid formation in *Datura* radicles no more than 3 mm. long, but not in those 2 mm. long or less. Synthesis *de novo* appears, therefore, to set in at the very outset of germination, and is characteristically associated with high metabolic activity. The alkaloids of the ripe seed are survivors from the activity of the post-fertilization stage of the ovule, which at first contains alkaloids in all its tissues. The inner tissues lose their alkaloids during maturation either by breakdown *in situ* or by migration to the periphery.

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A Product of *Pseudomonas æruginosa* Active *in vitro* against *M. tuberculosis*

INFORMATION recently to hand in the lay press[1] that Theorell, Davide and Sjögren have developed an anti-tuberculosis remedy from the pyocyanic bacillus has prompted, at this early stage of its investigation, the following record of the isolation and characteristics of what may prove to be a similar organism.

On the assumption that if active antagonists to *M. tuberculosis* exist, they are likely to be found in the sewage tank of a tuberculosis sanatorium, various samples were treated by the Dubos enrichment culture method, tubercle bacilli being added at intervals over a period of five months. At the end of this time, an organism was isolated which showed a marked antagonistic effect to *M. phlei* and *M. tuberculosis*. This organism was identified as a strain of *Pseudomonas æruginosa*. The supernatant fluid of a twenty-day culture of this bacillus is inhibitory to a heavy inoculum of *M. tuberculosis* in a concentration of 1 in 80, and a crude chloroform extract is inhibitory in a concentration of 1 in 128,000. Even low concentrations are bactericidal in fourteen to twenty days. Exposure of *M. tuberculosis* to the action of the organism or its culture fluid extracts over short periods causes thickening, shortening, irregularity and beading, with progressive loss of acid-fastness. After some days, lysis of acid-fast organisms occurs.

The action of the Waterfall strain appears to be specific, as other strains of *Pseudomonas* tested have shown no antagonism to acid-fast bacteria. Further, in testing the activity of this particular strain against certain non-acid-fast types (*Staphylococcus aureus*, *Streptococcus hæmolyticus* and *Escherichia coli*), no antibacterial effect was observed.

The active substance is relatively heat-stable, but passage through a Seitz filter considerably reduces its potency. The most active preparations have so far been obtained from growth on a broth or liquid egg medium, but the antibacterial agent may also be obtained from growth on Youmans' or Dubos' medium. Chloroform extraction does not remove all the active material.

With the crude mixtures so far obtained, toxic effects are apparent in animals. 5 ml. of sterile culture fluid are sufficient to kill a guinea pig in twenty-four hours, while a mouse will survive a single subcutaneous injection of only 3–4 mgm. of a chloroform extract.

It has long been recognized that *Pseudomonas æruginosa* may secrete various antibacterial substances, among which are pyocyanine and its derivatives[2]. That the substance active against acid-fast organisms is not pyocyanine is suggested by the inactivity of ordinary strains, and by the fact that we have found pure *l*-hydroxy phenazine to be inhibitory in, at most, a concentration of 1 in 20,000.

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Dec. 17.

[1] *News from Sweden*, Sept. 18, 1946 (Amer.-Swedish News Exchange, Inc., New York).

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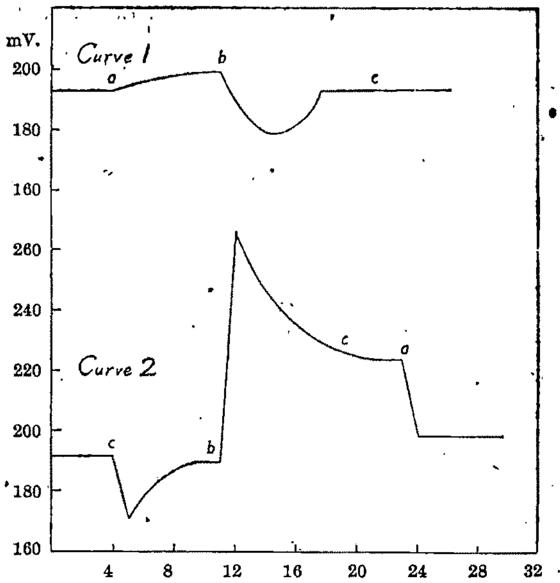
A Correlation between Redox Potentials and Synergisms in Resting Bacteria

THE destruction of nicotinic acid by suspensions of resting *Pseudomonas fluorescens* has been shown to be an enzymatic oxidation[1]. We have found that the oxygen uptake was decreased when methylene blue was added, but was not affected upon addition of sulphapyridine. However, after addition of a mixture of these compounds, a synergistic inhibition was observed.

The bactericidal and bacteriostatic effects of oxidation-reduction indicator dyestuffs have often been correlated to their poising action. It was, therefore, believed that an inhibitory synergism in which such a dyestuff is involved might manifest itself in changes of the oxidation-reduction potential of the system. Accordingly, a test was carried out in which the redox potential of phosphate-buffered and aerated suspensions of resting *Pseudomonas fluorescens* was measured with the Beckman *p*H meter, against a blank platinum electrode.

The changes in the E.M.F. are recorded graphically in the accompanying figure. Curve 1 indicates at point *a* an increase of the E.M.F. upon the addition of methylene blue to a buffered bacterial suspension and nicotinic acid at equilibrium. When sulphapyridine was added, at *b*, a decrease was observed. After equilibrium had been reached again, further addition of nicotinic acid (*c*) did not change the E.M.F. Curve 2 shows an initial decrease of the E.M.F. upon the addition of nicotinic acid (*c*) to the buffered bacterial suspension; after equilibrium was reached, sulphapyridine (*b*) brought about an increase in the



ADDITIONS MADE TO BUFFERED SUSPENSIONS OF RESTING *Pseudomonas fluorescens*: *a*, METHYLENE BLUE; *b*, SULPHAPYRIDINE; *c*, NICOTINIC ACID

E.M.F., which decreased and remained constant even after the addition of more nicotinic acid. When methylene blue was added (*a*), a sharp decrease of the E.M.F. occurred. It was thus found that the sequence of addition of methylene blue and sulphapyridine was significant.

Notwithstanding the difficulty of obtaining reproducible values for redox potentials in biological systems, it is suggested that the synergism of methylene blue and sulphapyridine in resting *Pseudomonas* can at least be partially explained by a change of the redox potential, the sign of the change depending upon the sequence of addition of the components. Guest and Salle[2] have observed that cations of the same element but of different valency show synergism in bactericidal action. The observations recorded here would indicate that synergisms, the factors of which poise the system to different redox potentials, can be partially explained; they give rise to potential differences within the bacterial suspension, which are greater, because of the reversal of sign, than those caused by each component alone, and are hence more effective.

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[1] Nichol and Michaelis, in the press.

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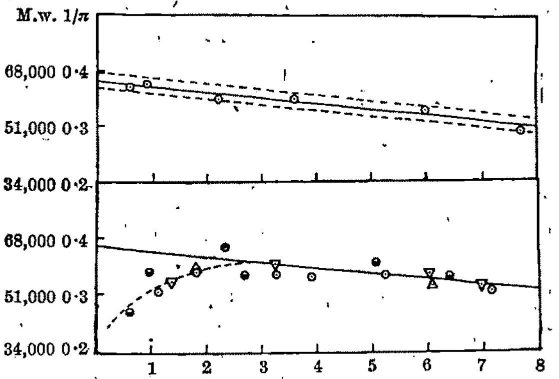
Osmotic Pressure of Fœtal Sheep Hæmoglobin

PREVIOUS osmotic pressure measurements on fœtal and maternal goat hæmoglobin[1] showed no significant differences in the molecular weights, which seemed in close agreement with the value of 68,000 reported for sheep hæmoglobin by Adair[2]. The present communication records some osmotic pressure measurements on the hæmoglobins of sheep fœtuses, aged 80, 92, 98, 102 and 112 days. The period of gestation in sheep averages 147 days.

Hæmoglobin solutions prepared by the method of Adair and Adair[3] were dialysed against $M/15$ phosphate buffer of pH 6·8. Osmotic pressure measurements were carried out by the method of Adair[4], the same buffer being used throughout.

The calculation of molecular weights from the osmotic pressures by a modification of van t' Hoff's law, and the determination by extrapolation of π_0, or the limiting value of the ratio P/C in the infinitely dilute solution, have been described by Adair and Robinson[5].



C = gm./100 ml. of solution. $1/\pi = C/P$.
Age of fœtuses in days: ◐ = 80, ● = 92, △ = 98, ▽ = 102, ⊙ = 112

The upper graph shows the relationship between $1/\pi$ and C obtained on a sample of maternal sheep hæmoglobin. Molecular weights corresponding to different values of $1/\pi$ are also presented. The calculated molecular weight is about 67,000. In the lower graph, data obtained on a number of samples of hæmoglobin from five fœtuses are shown. Extrapolation of the points obtained at higher concentrations indicate a molecular weight of 65,500 ± 2,500. At lower concentrations, however, the values of $1/\pi$ fall below the values expected from such extrapolation. The deviations are of a magnitude difficult to attribute to experimental error alone, and suggest the dissociation of fœtal hæmoglobin into smaller molecules on dilution. Further experimental data, however, are required on this point.

Andersch, Wilson and Menten[6] reported differences in the sedimentation constants of hæmoglobins prepared from human new-born infant and adult bloods. Diffusion constants were not measured, so the molecular weights were not calculated; but if the former are identical, their findings would indicate that human infant hæmoglobin has a molecular size half that of adult hæmoglobin.

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Experiments with Different Methods of Isolating Physiological Mutations of Filamentous Fungi

During recent years, I have tried various methods of isolating considerable numbers of X-ray induced physiological mutants in fungi, *Ophiostoma multiannulatum* being the chief organism experimented on[1]. Of some six hundred mutants produced in this fungus, at present 463 are at least preliminarily classified, and thus the material in this case seems to be big enough to permit some general conclusions to be drawn as to the methods employed. 218 of these mutants have been isolated by the aid of some 'concentration method', the other 245 by the so-called 'total isolation method'. Some of the former were obtained from irradiated ascospores; but most of them, as well as all the latter, were produced by irradiating conidia of the (+)-strain No. 11.

The methods first mentioned imply a concentration of the mutants, in so far as the normal mycelia are to a great extent sorted out in some way before the isolation. The best procedure turned out to be the following one, here described quite briefly. The irradiated conidia are soaked with water at a low temperature for three days, and then they are transferred to a minimum nutrient solution at + 25° C. There the physiologically normal conidia germinate rapidly and develop small mycelia; the conidia with mutated nuclei, on the other hand, remain ungerminated, or develop only short hyphæ. Thus most of the former are removed by sieving the culture through a suitable filter, and most of the latter—together with all the conidia killed by the irradiation—are to be found in the filtrate. After washing the filtrate (by centrifuging), the latter part of the procedure is repeated once or twice more. The conidia in the final filtrate are then brought on to agar-plates containing malt-extract and yeast-extract. About 12–15 per cent of the mycelia developing in these plates are physiological mutants.

In using the 'total isolation method', the irradiated conidia are directly disseminated into malt-yeast-extract agar-plates, and all developing mycelia are isolated and tested. Of 13,405 mycelia isolated in this way, 245 turned out to be physiological mutants, that is, 1·83 per cent of the conidia surviving after irradiation and *c.* 0·02 per cent of all the conidia irradiated.

The accompanying table of the physiological properties of the mutants hitherto analysed shows that some types of mutations are obtained to about the same extent in both methods. Thus they are suitable for the parathiotrophic mutants (requiring bivalent sulphur), for the amino-acid-deficient mutants, and for those requiring a nucleotide constituent. As to the last-mentioned group, however, it will be noted that all the four guanine-requiring mutants have been obtained by means of concentration methods. The same holds good for the *p*-aminobenzoic-acid-heterotrophic mutants, among those requiring vitamins, whereas the great majority of the pantothenic acid and inositol-heterotrophic mutants have been obtained by the total isolation method. Possibly with the exception of the inositol-heterotrophic mutants, the mutated material is not yet extensive enough to decide whether the divergences in question are due to the different methods of isolation, or merely due to chance.

Here it may further be mentioned that a part of the irradiation experiments was performed with conidia impregnated with uranium (as uranyl nitrate). In this way a somewhat higher rate of mutations was obtained; but no definitely demonstrable changes in the qualitative composition of the yields of mutants could be observed, whether these were obtained by one or the other method of isolation.

Essential substance	Number of mutants isolated			
	Isolation method			Total
	'Concentration' *a*	'Concentration' *b*	'Total isolation' *b*	
Reduced sulphur	10	30	34	74
An amino-acid:				
Arginine	—	56	42	98
Lysine	—	22	32	54
Methionine	1	7	9	17
Aspartic acid	—	—	1 ?	1 ?
Not identified	—	3	5	8
A nucleotide constituent:				
Uracil	1	14	26	41
Hypoxanthine	4	43	51	98
Adenine	—	3	4	7
Guanine	1	3	—	4
Vitamin A				
Biotin	1	2	2	5
p-Aminobenzoic acid	3	1	—	4
Pantothenic acid	—	—	6	6
Inositol	—	2	18	20
Niacin	—	2	6	8
Unknown factor	1	8	9	18
Total	22	196	245	463

(*a*) Mutants obtained from irradiated ascospores. (*b*) Mutants obtained from irradiated conidia (Strain No. 11).

On comparing the results summed up in the table with those obtained in *Neurospora* by American workers[2], the following differences seem to be particularly striking[3]. Induced amino-acid deficiencies are found comparatively more often in *Neurospora* than in *Ophiostoma*, and many more different amino-acids are concerned. Moreover, in *Neurospora* more types of auxo-heterotrophies (requiring different growth-substances) have been produced, for example, lactoflavine and choline heterotrophies. *Ophiostoma*, on the other hand, is characterized by the numerously occurring parathiotrophic strains, and by the big group of mutants requiring some nucleotide constituent.

The concentration method here described seems to be applicable to other filamentous fungi too, although, of course, the details of the procedure must be worked out specially for each object.

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Dec. 16.

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[3] Cf. Fries, N., *Trans. Brit. Myc. Soc.*, in the press.

Growth of a Planktonic Green Alga at Various Carbonic Acid and Hydrogen-Ion Concentrations

The use of phosphate buffer mixtures when culturing Algæ has been shown to have several disadvantages. High phosphate concentrations are often injurious to Algæ, and in alkaline solutions precipitates of slightly soluble phosphates are formed, thus withdrawing from the Algæ elements necessary for growth. Nor has it been possible to make growth determinations at *p*H higher than 8·2 on account of absorption of carbon dioxide from the air, which rapidly decreases the pH. In the experiments described here it has been possible partly to avoid these difficulties by using carbonate-bicarbonate buffer mixtures.

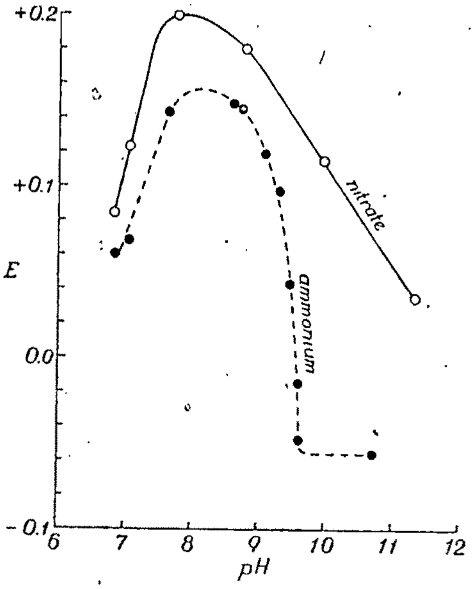
A sterile single cell culture of *Scenedesmus quadricauda* (Turp.) Bréb. has been used. The basic nutrient solution consisted of: $NaNO_3$, 300 mgm.; Na_2CO_3, 2,410 mgm.; K_2HPO_4, 11·2 mgm.; $MgSO_4.7H_2O$, 50 mgm.; $Ca(NO_3)_2.4H_2O$, 30 mgm.; ferric citrate, 2·7 mgm.; citric acid, 2·7 mgm.; $MnSO_4.5H_2O$, 0·05 mgm.; glass distilled water, 1,000 ml. Growth was measured photometrically, and expressed in extinction values. 0·001 E corresponds to some 10 cells per µl. The cultures have been inoculated by material cultivated for four days in this solution, after 50 ml. of 0·544 N hydrochloric acid per litre had been added, thus depressing the pH from 11·1 to about 7·5. This solution was centrifuged, and the cells were washed in sterile water, after which they were used for inoculation. The cultures were illuminated by a 500-watt incandescent lamp and a mercury vapour lamp, HgH· 1,000, together giving a light intensity of 2,200 lux. The temperature was 25° C.

In the experiments the Algæ were cultured in Jena glass tubes with 10 ml. of solution in each. The pH of the basic solution was regulated by adding carbon dioxide to the gaseous phase of the tubes, which were then immediately closed by rubber stoppers, sealed with paraffin. The carbon dioxide was added at about 15 mgm./min. The tubes were shaken for two hours, and then the pH was measured of two of the (usually) four parallel tubes which had been treated with carbon dioxide for the same time. The other two tubes were illuminated for 20 hours and then pH was determined. From the two pH-determinations it was possible to compute the consumption of carbon dioxide during growth, making allowance for the increase in alkalinity that followed from nitrate assimilation, and which was determined as 0·2 milliequivalents per litre at a growth of 0·1 E.

From several determinations one gets the value of 2·27 ± 0·05 mgm. carbon dioxide consumption per tube at a growth of 0·1 E, which corresponds to 0·62 mgm. of carbon. According to my observations, this growth corresponds to 0·856 ± 0·007 mgm. of dry substance, which will consequently contain about 70 per cent of carbon, indicating that fats constitute a great part of it.

From these experiments we get the continuous curve in the accompanying graph. The abscissæ are the mean values of the pH-determinations before and after growth, which never differed more than 1·1–1 pH, usually less. In another experiment the dipotassium hydrogen phosphate was omitted from the nutrient solution, and the same growth curve was then obtained. This shows that the cells have accumulated enough phosphate for optimal growth during 20 hours under these experimental conditions, and that the slight turbidity from precipitated phosphates, obtained at the highest pH-values, is without influence upon growth.

If ammonium is given to the Algæ instead of nitrate, the discontinuous curve in the graph is obtained. The two sets of experiments were inoculated with the same number of cells, and the amounts of nitrate and ammonium were equivalent. The growth in nitrate is always superior, but at pH 9·5 the growth in ammonium falls very rapidly, and at a higher pH, where the concentration of free ammonium hydroxide rises, chlorophyll is destroyed, thus causing a decrease in absorption of light. Both in the case of nitrate and ammonium, pH rises during growth, according to the consumption of carbon dioxide, but somewhat less in ammonium than in nitrate.



GROWTH OF *Scenedesmus quadricauda* AT VARIOUS pH VALUES WITH NITRATE AND AMMONIUM AS SOURCES OF NITROGEN

A preliminary experiment indicates that growth is depressed more by high concentrations of carbon dioxide and CO_3^{--} than by HCO_3^-, and that the maximum of the curves depends on these conditions.

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Dec. 13.

Use of 'Gammexane' Dust against Domestic Cockroaches

MOGADISHU, capital of Somalia (ex-Italian Somaliland), is seriously infested with three species of domestic cockroach, which Dr. B. P. Uvarov of the Anti-Locust Research Centre has kindly identified for me as *Periplaneta americana* (L.), *Blattella germanica* (L.) and *Supella supellectilium* Serv. Almost all houses contain a sufficient number to cause frequent damage to fabrics and tainting of food and cupboards. Constant cleaning or spraying with pyrethrum or D.D.T. produced poor results, and it was decided to attempt control with 'Gammexane' dust. I am indebted to Mr. D. E. Kevan of the Department of Agriculture, Kenya, for suggesting this method to me.

The 'Gammexane' dust was as supplied for use in locust bait, and contained 10 per cent of 'active ingredient'. It was applied with a simple hand-duster which delivered a strong fine jet of dust. During the day-time the cockroaches sheltered mainly on the shaded undersides of horizontal surfaces, such as shelves in cupboards, and the dust was, therefore, only applied to such places and behind articles of furniture. The results far exceeded expectations. Immediately after dusting, the insects showed signs of distress, and most of them left their hiding-places and ran up the walls. Within an hour many were unable to stand, and after twelve hours all *P. americana* were dead or dying, except the largest specimens, and the latter were incapacitated and died later.

Several premises were treated with the same results; but the kill was poor if the dusting was done at night-time, presumably because the insects had left their hiding-places and were generally distributed.

The dust did not affect the eggs, but for a few days after treatment dead first instar nymphs were found; this indicates that there was some residual effect. The eggs of *B. germanica*, which are carried by the females in the oothecæ until they hatch, were swept up with the dead bodies, and could be destroyed by burning. It seems unlikely, however, that nymphs from such eggs would survive, as their first food would presumably be the 'Gammexane'-coated bodies of dead cockroaches. The eggs of the other two species remained behind in the oothecæ attached to the hiding-places, and some of these ultimately produced nymphs that survived. It was, therefore, found advisable to dust again after an interval of three or four weeks.

Premises so treated remained reasonably free of cockroaches for about three months; but they were gradually re-invaded, and after three months it was again possible to find the insects in fair numbers.

It was found that 250 c.c. of dust was an adequate dose for one dusting of a house or flat containing a kitchen and four other rooms, and that this gave the required kill without leaving a noticeable deposit of dust. During dusting, the operator suffered temporary discomfort from irritation of the nostrils and throat, but no after-effects were observed. Treatment produced an unpleasant smell that lasted for about two hours, but in cupboards, etc., the smell lingered for a few days. It was, however, generally considered to be far less unpleasant than the smell of the insects.

This note has been written in the hope that it may be of use to residents in cockroach-infested places, and because it is considered that the method is worthy of further investigation which I am unable now to undertake.

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Nuclear Magnetic Resonance at Low Temperatures

Measurements of radio-frequency absorption and dispersion due to nuclear magnetic resonance have been made at liquid hydrogen temperatures using the same experimental arrangement as described in a recent note[1]. We have observed very strong resonant effects due to the protons in liquid and solid hydrogen. On account of the increased Boltzmann factor, the signals were considerably greater than those obtained with substances at room temperature, and were several thousand times the noise voltage. There appeared to be no appreciable change in the phenomena on solidification of the hydrogen. In agreement with the conclusions of Lasarew and Schubnikow[2] from their experiments on the susceptibility of solid hydrogen, we find the relaxation time for nuclear orientation to be less than one second. The absorption line was very sharp, and we estimate the width to be less than 0·5 gauss (2 kc./sec.).

A number of other nuclei have been investigated at liquid hydrogen temperatures. In lithium fluoride both the lithium and fluorine resonance were observed. Neither of these resonances could be detected in this compound at room temperature. Observations on lithium chloride failed to reveal the lithium resonance. A resonance was obtained for sodium in sodium fluoride but could not be found in sodium chloride. The fact that a resonance cannot be observed may be either because the relaxation time is very long or because there is exceptional broadening of the line by spin-spin or spin-lattice interaction. In the latter case it may be possible to obtain measurable effects by working at still lower temperatures and, in order to test this, experiments are now in progress at liquid helium temperatures.

B. V. Rollin
J. Hatton

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Dec. 20.

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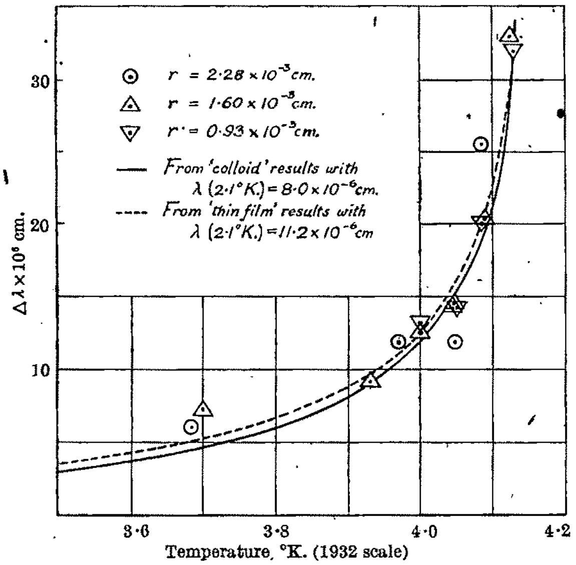
Penetration of Magnetic Field into Superconducting Mercury

It is well known that a magnetic field is almost completely excluded from a superconductor, so that a long cylinder has a diamagnetic susceptibility χ_0 which is $1/4\pi$ for a field parallel to the cylinder axis, or $1/2\pi$ for a transverse field. The magnetic field does, however, penetrate slightly, so that the actual diamagnetic susceptibility χ should be slightly smaller than χ_0, and elementary considerations show that we should have

$$\chi/\chi_0 = 1 - 2\lambda/r, \qquad (1)$$

where λ defines a 'penetration depth' and r is the cylinder radius. Previous experiments by one of us[1] on colloidal mercury, and by Appleyard and others[2] on thin mercury films (in both cases involving specimen size comparable to or smaller than λ), showed that λ is of the order of 10^{-5} cm. and increases several times as the temperature approaches the transition point (4·17° K.). Thus χ for cylinders with radii of order 10^{-3} cm. should vary by a few per cent close to 4·17° K.

We have made accurate relative measurements of χ on three specimens: (*a*) a mercury-filled glass capillary (length 28·9 cm., radius $2{\cdot}28 \times 10^{-3}$ cm.) wound into a spiral so that it is effectively a long cylinder transverse to the field; (*b*) a bundle of 98 mercury-filled capillaries of mean length 1·83 cm. and mean radius $1{\cdot}62 \times 10^{-3}$ cm., with the field parallel to the cylinder axes; and (*c*) a bundle similar to (*b*) but containing 198 capillaries of mean length 1·83 cm. and mean radius $0{\cdot}93 \times 10^{-3}$ cm. The method of measurement was an improved version of that used in the colloid work, and relative values of χ could be measured with an accuracy of about 0·25 per cent in fields as small as 5 gauss, with only 10^{-3} c.c. of mercury (absolute values could be only roughly measured, since the volume of mercury was not very accurately known, and for other reasons). Changes of χ with temperature of the expected order of magnitude were found, which varied with r as



predicted by equation (1), and from the results the variation of $\Delta\lambda = \lambda - \lambda$ (2·1° K.) with temperature shown in the accompanying graph was deduced.

The experimental points agree within the limits of experimental error both with the curve deduced from the colloid work (in which only relative values of λ were accurately measured) if λ (2·1° K.) is chosen to be $0{\cdot}80 \times 10^{-5}$ cm., and with the curve deduced from the thin-film results if λ (2·1° K.) is chosen to be $1{\cdot}12 \times 10^{-5}$. It has been pointed out by Ginsburg[3] that if the surface-energy per unit area, α_n of normal mercury, is appreciably different from α_s, that of superconducting mercury, the thin-film experiments (in which only critical fields were measured) should yield not λ, but $\lambda + \beta$ where $\beta = 8\pi\,(\alpha_n - \alpha_s)/H_c^2$ (H_c is critical field). If then both the colloid and the thin-film results are exactly correct, we can deduce, with the help of the present experiments (which enable the hitherto unknown absolute values of λ of the colloid work to be estimated), that β is of the order $0{\cdot}4 \times 10^{-5}$ cm., and, moreover, that β varies only slightly with temperature. Unfortunately, however, the accuracy of neither the colloid nor the thin-film work is sufficient to make this interpretation of their slightly different results certain, and until more accurate data are available this estimate of β can be regarded only as an upper limit.

Our confirmation of equation (1) is interesting in view of the doubt cast on its validity by experiments of Casimir[4], in which essentially equation (1) was tested for r of order 0·7 cm. by an A.C. method. Casimir found that λ did not appear to vary with temperature by nearly so much as the earlier work predicted, and it seemed that perhaps the same parameter λ could not be used both for $r \gg \lambda$ and $r \gtrsim \lambda$. The present experiments show that such an assumption is unnecessary and suggest that some source of error may have been present in Casimir's experiment. Prof. Casimir has been kind enough to inform us that he has recently found such a possible source of error. The varying bath pressure, acting on the evacuated tube on which the measuring coils were mounted in his experiment, may have caused these coils to expand as the temperature was reduced; he finds from a rough estimate of this effect that it is of the right order of magnitude to remove the disagreement.

A fuller account of this work will be published elsewhere.

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Dec. 16.

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Emission of Secondary Electrons from Nickel and Molybdenum by Neutral Atoms of Mercury and Potassium

WE wish to describe briefly some experiments with high-speed neutral atoms produced by the neutralization of positive ions. A homogeneous beam of neutral atoms of mercury, with varying energy, was produced by a method devised by Oliphant[1]. The fast mercury ions which were pulled out of a hot cathode mercury arc were made to pass through a narrow metallic canal, where a large fraction of them collide with its walls almost at grazing incidence and are neutralized but retain their initial speed. The residual positive ions were filtered out of the mixed emergent beam by an electrostatic field applied between two plates placed beyond the canal.

Neutral atoms of potassium were produced by passing an accelerated beam of potassium ions through potassium vapour, where they are neutralized by 'electron exchange' but retain their original kinetic energy. The residual positive ions were filtered out from the beam as in the previous case. These beams of neutral atoms, ranging in energy from 1,200 to 2,500 volts for mercury and from 1,200 to 2,000 volts for potassium, were made to fall on a metal target; under these conditions, the neutral beam ejects electrons both from nickel and molybdenum targets.

The secondary emission, which rises almost in proportion to the energy over the range studied, is greater for a dirty target surface than for a well-degassed one. The energy distribution of the electrons is in all cases Maxwellian, corresponding to the effective temperatures listed below for typical conditions:

MERCURY ATOMS OF ENERGY 1,500–2,500 VOLTS

Undegassed nickel	40,000–45,000° K.
Degassed nickel	29,000–34,000° K.
Undegassed molybdenum ..	40,000–45,000° K.
Degassed molybdenum ..	30,000–33,000° K.

POTASSIUM ATOMS OF ENERGY 1,200 VOLTS

Undegassed molybdenum	35,000° K.
Degassed molybdenum	29,000° K.

It was observed that some of the incident atoms were scattered from the target and were able to release secondary electrons from neighbouring metal electrodes. More mercury atoms were scattered by a dirty molybdenum surface than by a clean one, but the reverse was found with potassium atoms.

The details of this work will be published at a later date.

We wish to express our sincere thanks to Prof. M. L. Oliphant for his helpful advice and encouragement throughout the work.

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[1] Oliphant, M. L., *Proc. Roy. Soc.*, A, **127**, 373 (1930).

Self-Recovery of Metals

IN two recent communications in *Nature*[1,2], evidence from X-ray photographs was given on the annealing of filed copper powder at room temperature. Similar observations of other investigators were also mentioned (the authors, however, omitted to mention the detailed investigation on the self-annealing of rolled copper by M. Cook and T. Ll. Richards[3]). Further, attention was directed to the marked effect of impurities on the rate of self-recovery and recrystallization.

It may be remarked that observations closely related to those reported in these communications were made several years ago by other investigators. In this connexion in particular, the experiments of Calvet, Trillat and Paič[4] with aluminium of the highest degree of purity may be mentioned. For example, it was found by these investigators that severely rolled aluminium of 99·9986 per cent purity shows recrystallization, as indicated by the appearance of sharp interference spots, according to the following table:

Temperature		Time of recrystallization		$T_R \log_{10} 4\nu t$ ($\nu = \sim 5{\cdot}6 \times 10^{12}$)
			sec.	
0° C.	$T_R = 273°$ K.	⩾ 48 days	$t = \geqslant 4{,}150{,}000$	⩾5500
25	298	>336 hr.	>1,210,000	>5840
40	313	~40 hr.	~ 144,000	~5840
60	333	6 hr.	21,600	5940
100	373	1 min.	60	5700
150	423	5 sec.	5	6000

In the last column we give the values of $T_R \log_{10} 4\nu t$, where T_R is the temperature (in ° K.) and t the corresponding time of recrystallization, and ν the characteristic frequency for aluminium. The approximate constancy of this expression shows that the recrystallization at all temperatures follows Van Liempt's "law of corresponding states of recovery"[5], according to which corresponding times and temperatures of recrystallization (or recovery) are connected by a formula of type:

$$\nu t \exp -S/kT_R = \text{const. (with log const.} \ll \log \nu t),$$

in which S represents the activation energy for interchange of atoms. The fact that T_R and t satisfy this 'law' means that the self-recovery at room temperature is not essentially different from that at higher temperatures, only its velocity is correspondingly smaller. A similar conclusion was reached by Cook and Richards (loc. cit., p. 169). As to the enormous influence of small amounts of impurities on the course of the recovery, it follows from Calvet's experiments that its rate in rolled aluminium with 99·996 per cent metal is *at least* 2,000 times as slow as in the 99·9986 per cent metal at the same temperature (100° C.).

I have published detailed considerations of these phenomena elsewhere[6].

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der Technische Hoogeschool,
Delft. Dec. 3.

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[5] Liempt, J. A. M. van, *Rec. Trav. Chim. Pays-Bas*, **53**, 941 (1934); *Z. anorg. allg. Chem.*, **195**, 366 (1931); *Z. Phys.*, **96**, 534 (1935).

[6] Burgers, W. G., "Rekristallisation, Verformter Zustand und Erholung", "Handbuch der Metallphysik", III, 2 (Akad. Verlagsgesellschaft, Leipzig; Edwards Brothers, Inc., Ann. Arbor, Michigan, 1944), §§ 77, 79, 150 and following.

Application of Similarity Principles to Thermal Transport Systems

THE use of similarity laws is well established for mechanical transport systems, that is, systems in which the dependent variable (A) is the flow or transport of matter. Examples of dimensionless numbers (B) used in such systems are the Froude number for mechanical systems depending solely upon the action of gravity, the Reynolds number (R_e) for mechanical systems depending upon the action of viscosity, and the number introduced by Davis[1] for systems depending upon the action of density changes in hot gases. Although heat transfer is involved in the last of these three examples, it is really a mechanical system, since the heat is conveyed by the mechanical motion of the fluid concerned. The applicability of model results expressed in the form $A = f(B)$ to the original system is based upon the fact that the motion of any element of the fluid obeys the fundamental law of dynamics, $p = mf$, even though the integration of this law for the three-dimensional extended system is too complex for mathematical treatment.

When heat is transferred not by mechanical movement of a fluid but by conduction or radiation, it is often equally impossible to integrate the fundamental laws throughout the three-dimensional system. An example of great practical importance is the transfer of heat by radiation from a flame which changes temperature appreciably as it flows along a furnace system. In such a case, two transport processes are at work: (i) the mechanical flow of gas along the system coupled with energy release by combustion; (ii) thermal transport by radiation from the flame to the surroundings. The dependent variable is the distribution of heat transfer as a function of position along and across the furnace, so that a typical dimensionless criterion of it is the ratio $A = H_n/H_1$, where H_n is the heat transfer per unit area and time at a general section of the surface n, and H_1 that at a standard section, say, that under the centre of the flame.

Since Rummel[2] has shown that the release of energy by combustion in a diffusion flame is purely governed by considerations of gas mixing, the dimensionless criterion for the first transport process is the Reynolds number R_e. This is not, however, a sufficient criterion of similarity since, for example, if the radiation temperatures are very different in the model and in the original, the gas will not in general be cooled by radiation by the same amount in the same proportional distance even though the proportional flame-lengths are made the same by using the same Reynolds numbers. We have, therefore, to express the model law in the form

$$A = f(R_e, N),$$

where N is a suitable thermal transport criterion which must be given the same value in model and original before the model results can be generalized to the full-scale furnace with complete confidence.

In order to find what is the characteristic number N for thermal transport, we have to find a law analogous to Newton's first law of motion, $p = mf = d(mv)/dt$, which expresses the rate of change of momentum of the elementary unit of the system. In the case of thermal transport, the analogous quantity expressing the thermal *vis impressa* is clearly the time-rate of heat transfer H. Now just as in mechanical similarity theory the general force p

is replaced by the special kind of force law involving a physical coefficient such as the viscosity, so here the driving force must be measured by a law such as

$$H = K\,\frac{T_a - T_b}{D} \quad \text{for conduction} \qquad (1)$$

$$\text{or } H = \sigma E\,(T_a^4 - T_b^4) \quad \text{for radiation: finite temperature difference} \qquad (2)$$

$$\text{or } H = 4\sigma E T_1^3 \delta T \quad \text{for radiation: small temperature difference} \qquad (2a)$$

(K is thermal conductivity of conductor; D is thickness of conductor; σ is Stefan's constant; E is combined emissivity of flame and surroundings; T_a, T_b are temperature of flame and surroundings, ° K.)

It follows that in cases where, for example, radiation is the dominant factor, the model law is that the dimensionless number N is given by

$$N = \frac{H}{\sigma E\,(T_a^4 - T_b^4)}; \qquad (3)$$

and must have the same value in the model and in the original. If T_a/T_b is the same in model and original, N can be written

$$N = \frac{H}{\sigma E\,(\theta^4)}, \qquad (4)$$

where θ is the absolute temperature of any portion of model and original. This means that the temperature of the model system, the emissivity of the flame and the linear scale can be changed provided the total rate of heat input (HL^2) is adjusted to give the factor N the same value as in the original system. The model must, of course, be geometrically similar, and the heating gases must burn in a way which is geometrically similar to that of the original system. Clearly, also, the absolute temperatures T_a and T_b must be in the same ratio in the model and the original, unless T_b^4 is negligible compared to T_a^4.

If the working temperature of the model is governed by refractory considerations and its linear dimensions by economic ones, it will not in general be possible to have both R_e and N the same in the model and in the original. Hence it is necessary either to decide whether combustion flame-length or heat-loss cooling of the flame gases is the more important factor for model investigation, or else to make a departure from perfect geometrical similarity such as to give R_e and N the correct values. Thus by using two different length-scales on the model, one for the area of the gas and air inlets (to give correct R_e at the flame inlet) and the other for the combustion chamber (to give correct N), both flame-length and gas cooling can be given the correct proportional values. This is analogous to the use of different horizontal and vertical scales in tidal models.

It should be noted that the formulation of the law of heat transfer in a way analogous to the $p = mf$ equation enables the rate of entropy *increase* dS/dt, or of 'virtue' degradation[3], dV/dt, of the system to be evaluated. Thus

$$\frac{dV}{dt} = \frac{(T_a - T_b)^2}{T_a \times T_b} \times \frac{1}{\rho D} \qquad (5)$$

holds for the conduction law. We have, therefore, a numerical connexion between entropy and time as a special case of the general connexion referred to by Eddington[4].

It is hoped in a later communication to give a more detailed examination along these lines of the work carried out by my colleagues[5] on a model open-hearth furnace.

M. W. THRING
British Iron and Steel Research Association,
London. Dec. 4.

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Surface Tension of Nuclear Matter and the Enumeration of Eigenfunctions of an Enclosed Particle

THE enumeration of eigenfunctions for a bounded continuum to a closer approximation than the Rayleigh asymptotic expression has, in recent years, largely because of its significance in problems of room-acoustics, received considerable attention[1]. The number of eigenfunctions with their wave-numbers equal to or less than K is given by

$$a(K) = g\left\{\frac{4\pi V}{3}K^3 + \theta\,\frac{\pi S}{4}K^2 + \frac{L}{8}K + O(K)\right\}, \qquad (1)$$

where the value of θ depends on the boundary condition which the eigenfunctions (U) have to satisfy; $\theta = -1$ when U vanishes at the boundary, and $\theta = +1$ when $\partial U/\partial n$ (n being the normal to the surface) vanishes at the boundary. We could contemplate other possible boundary conditions for which θ could take values between -1 and $+1$. V is the volume of the enclosure, S its surface area, and L has the dimension of length, which for a rectangular enclosure is the sum of the edge-lengths. That the volume term is independent of the shape of the enclosure was shown by Weyl (1911); for the surface term this is assumed, but a demonstration is lacking. The L-term is still more uncertain. (The order term $O(K)$ is probably of order less than $K^{3/2}$.) The effect of retaining the surface term in equation (1) on Stefan's law of radiation and on Debye's theory of specific heat was dealt with by one of us (D. S. K.) and has also been recently treated by Brager and Schuchowitzky[2]. They have further derived, by applying (1) to a completely degenerate electron gas, the following expression (assuming one free electron per atom) for the surface tension of metals,

$$\sigma = \alpha(\rho/A)^{4/3} \text{ dyne cm.}^{-1}; \quad \alpha \sim 5{\cdot}6 \times 10^4, \qquad (2)$$

where A is the atomic weight and ρ (gm. cm.$^{-3}$) the density of the metal. It is interesting to observe that the above equation, but with the value of α reduced by a factor of about $\frac{1}{2}$, was obtained on certain assumptions from the electron theory of metals by Gogate and Kothari, jun.[3], who found the equation in reasonably good accord with experiment; the experimental values of ρ, σ give α as about $2{\cdot}2 \times 10^4$.

In the present note, we examine the effect of the surface term in (1) on the statistical properties of nuclei, adopting the free-particle model (neutron-proton gas). It is somewhat remarkable that an elementary straightforward calculation (involving no assumptions about nuclear forces, the calculation being based on the free particle model) gives for the surface-dependent term of nuclear energy the value

$$G = \Gamma A^{2/3},$$

where A is the mass number of the nucleus, and Γ is about 20 MV. The value of Γ as deduced from empirical data on nuclear binding energies is about 10 MV.

For a completely degenerate ideal Fermi–Dirac gas, we obtain from (1)

$$\sigma = \frac{g\pi}{16}\frac{h^2}{m}\left(\frac{p_0}{h}\right)^4, \qquad (3)$$

where p_0 is given by the cubic equation

$$\left(\frac{p_0}{h}\right)^3 - \frac{3S}{16V}\left(\frac{p_0}{h}\right)^2 - \frac{3n}{4\pi g} = 0\,; \qquad (3a)$$

p_0 is the maximum momentum characterizing the Fermi distribution, n is the number of particles per unit volume, m the mass and g the weight-factor of a particle: σ is the surface tension. In the case of metals the second term in ($3a$) is negligible, and (3) reduces (taking m = electron mass, $g = 2$) to

$$\sigma = \frac{g\pi}{16}\frac{h^2}{m}\left(\frac{3n}{4\pi g}\right)^{4/3} = 5{\cdot}6 \times 10^4 (\rho/A)^{4/3}.$$

In the case of nuclei, the second term in ($3a$) is also significant. The values of Γ, taking m as the mass of a nucleon and $g = 4$ (as the number of protons and neutrons are nearly equal, we may regard the nucleon gas as consisting of similar particles, A in number, with $g = 4$), are given below for different values of A.

$$\Gamma = 4\pi r_0^2\sigma; \quad (r_0 = 2{\cdot}05 \times 10^{-13}\ \text{cm.})$$

A	20	100	200	∞
Γ (MV.)	48·5	27·5	23·5	13·4

The applications of (1) to a Bose–Einstein gas (liquid He II), where the surface tension becomes negative, to the dependence of magnetic properties on surface area and other allied problems will be treated elsewhere.

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Nov. 28.

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[1] Bolt, R. H., *J. Acous. Soc. Amer.*, **10**, 228 (1939). Husimi, K., *Proc. Physico-Math. Soc.* (*Japan*), **21**, 759 (1939). See also Morse, P. M., and Bolt, R. H., *Rev. Mod. Phys.*, **16**, 69 (1944). (The lattice points corresponding to $\rho^2 = n_1^2 + n_2^2 + n_3^2$ have been tabulated by Gupta, H. R. (*Proc. Nat. Inst. Sci. India*, in the press) for $\rho \leqslant 100$.)

[2] Kothari, D. S., *Science and Culture*, **6**, 246 (1940); *loc. cit.*, 247. Brager, A., and Schuchowitzky, A., *J. Chem. Phys.*, **14**, 569 (1946). In discussing the effects of surface area on specific heat of dispersed liquids (sprays) account must also be taken of capillary (surface) waves.

[3] Gogate, D. V., and Kothari, D. S., jun., *Phil. Mag.*, **20**, 1136 (1935).

Elements of Atomic Numbers 43 and 75

Prof. F. A. Paneth and also Prof. E. Segrè have directed attention (*Nature*, January 4, p. 8 and p. 24) to the unconfirmed claim by I. and W. Noddack to the discovery of element 43 which they named 'masurium'[1]. Apart from a fantastic patent specification[2], they brought forward no chemical evidence to show that they had discovered this element.

It will be recalled that the Noddacks (Mrs. Noddack was then Dr. Ida Tacke) claimed to have found elements 43 and 75, Mendeléef's eka- and dvi-manganese, in columbite and platinum ores. Their claim was disputed at the time by Prandtl[3] and by Zvjagintsev[4] and others. Eventually, however, Feit[5] isolated about a pound of potassium perrhenate (dvi-manganese was called 'rhenium' after Germany's 'Westmark') from molybdenum waste, and from this salt the new element was isolated. The Noddacks' claim was therefore accepted, although since then no reference has been made to any masurium or rhenium having been isolated from either columbite or platinum ores.

Meanwhile, Loring and Druce[6] discovered traces of dvi-manganese in crude manganese salts; Heyrovský and Dolejšek also reported the same discovery[7]. Loring had been looking for 'missing elements' since 1922, and in particular was seeking an element with higher atomic number than uranium. When the Noddacks published their claim, it was decided to publish what evidence there was of the presence of manganese congeners in its ores and crude salts. Soon after, Loring suggested[8] that dvi-manganese would be found associated with molybdenum. It was duly shown that molybdenum glance was the richest known source of this element, thus opening the way for Feit's work.

Loring, who died in 1944 from air raid injuries, intended to call the new element 'londinium' had not the name rhenium apparently been accepted. The name 'technetium' is now proposed for element 43. Will the validity of the claim of rhenium be re-examined in the light of all the evidence?

Gerald Druce

Battersea Grammar School,
London, S.W.16.
Jan. 6.

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[1] *Naturwissen.*, **13**, 567 (1925).

[2] English Patent 317,035, Feb. 27, 1928.

[3] *Z. angew. Chem.*, **39**, 1049 (1926).

[4] *Nature*, **117**, 622 (1926). *Z. angew. Chem.*, **40**, 256 (1927).

[5] *Z. angew. Chem.*, **43**, 459 (1930).

[6] *Chem. News*, **131**, 273 and 337 (1925).

[7] *Nature*, **116**, 782 (1925); **117**, 16 and 159 (1926); but see also **135**, 870 (1935).

[8] *Chem. News*, **133**, 276 (1926).

Study of Ocean Swell

The apparatus for the analysis of waves already described in *Nature*[1] has been used to form spectra of a long series of wave observations made at Pendeen and Perranporth on the north-west Cornish coast.

Comparison of the spectra with the meteorological charts of the North Atlantic shows that the swell arriving from a distant storm shows a more or less narrow band of periods, the minimum period of which decreases with time, in a manner which is consistent with the assumption that the swell travels from the generating area to the coast with a velocity equal to the classical group velocity appropriate to its period on arrival. In one example it is possible to show that the velocity of propagation does not differ by more than five per cent from the theoretical group velocity.

The observations in general suggest that the longest period exhibited by swell due to a distant storm is proportional to the maximum wind velocity in the storm, and does not depend upon the fetch or duration of the wind. This rule may have to be modified in studying generating areas of small size.

The swell is observed to travel great distances. Low swell has been received from a tropical storm off the coast of Florida, 2,800 miles from Cornwall, and from a storm near Cape Horn between 6,000 and 7,000 miles from Cornwall.

It is hoped to publish these results shortly, on behalf of the members of this research group.

N. Barber
F. Ursell

Admiralty Research Laboratory,
Teddington.
Jan. 25.

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[1] *Nature*, **158**, 329 (1946).

SIGNIFICANCE OF TRACE ELEMENTS IN PLANTS AND ANIMALS

THE significance of the presence of trace elements in plants and animals was discussed at a meeting of the Association of Applied Biologists held at the Imperial College of Science and Technology, London, on October 4.

Sir Edward Salisbury, in a brief general introduction, said that he was glad to be present because he had played a part in starting and integrating a series of investigations of mineral deficiencies under the Agricultural Research and Improvement Councils. It may not be generally realized that the crowded plants in a field of wheat are subject to competition and therefore to various deficiencies, which are enhanced if weeds are present. He pleaded for the researches to be pursued along broader lines than immediately practical ones. As an example, he mentioned the weeds that are known to be efficient in extracting manganese from the soil, and raised the question whether the next crop would benefit from the decomposition of such weeds, or would the deficiency be enhanced as a result of the depletion of the soil of its reserves of available manganese.

Prof. T. Wallace, Long Ashton Research Station, University of Bristol, dealt with the visual diagnosis of mineral deficiencies. The applicability of the method depends on the fact that plants which are deficient in any mineral nutrient develop well-defined and characteristic signs of the shortage in various organs, particularly in the leaves. To provide a basis for using the visual method on crop plants, it is necessary as a first step to produce the visual effects in the various crops and to record the results in a suitable manner. This is done by growing plants under controlled conditions of nutrient supply, usually in sand cultures, to produce the various effects, and afterwards checking the results under field conditions. The visual effects are suitably recorded as colour photographs, the negatives of which can be preserved without appreciable deterioration for several years.

In applying the method to field crops, cognizance is taken of soil conditions, such as texture, drainage, *p*H, dryness and cultural conditions, as the information is often helpful in ruling out certain deficiencies and in pointing to others. The presence of certain pests and diseases may complicate symptoms, and in extreme instances may even rule out the use of the method. Use is also made of indicator plants, that is, plants which are highly susceptible to particular deficiencies and also show characteristic signs of them, such as oats for manganese, sugar beet for boron, potatoes for potassium. Indicator plants may be used, combined with fertilizer and spray treatments, in special indicator plots to determine the likelihood of deficiencies occurring on land of unknown cropping potentialities.

The visual method has the great advantage of requiring no special equipment and is thus particularly suited to survey work, for which it has been widely used. It is also valuable in recording nutrient conditions in field experiments, especially with long-term crops such as fruit. Recently it has been successfully applied to the problem of resolving the injurious factors concerned in the failure of plants on acid soils.

For advisory purposes, visual diagnosis and the chemical tissue test method used together provide a very rapid and effective procedure for solving a wide variety of crop nutritional problems. Details of the method and its use in the field are given in Wallace's "The Diagnosis of Mineral Deficiencies in Plants" (with supplement 1944) (London: H.M. Stationery Office).

American workers have shown that qualitative chemical tests carried out on fresh plant material can be used in the study of fertilizer needs. A technique devised at the Long Ashton Research Station to test quantitatively a number of the easily soluble nutrients in fresh tissues within a short time was described by D. J. D. Nicholas. The method has been successfully used in the diagnosis of mineral deficiencies and toxicities in crop plants, and has served as an invaluable confirmatory test to the visual method. Its value as a diagnostic method is based on the fact that the extractable nutrients from healthy, as compared with unhealthy, plants usually show significant differences for the limiting mineral elements. In this way straightforward deficiencies of potassium, magnesium, calcium, phosphorus, nitrogen and manganese, and excess levels of manganese, chlorine and zinc can be readily confirmed in a short time. The tissue test method is being extended to include other trace elements.

The method involves a special field-sampling technique and preparation of test samples, followed by the extraction of the nutrients from the macerated tissues. Two reagents used for the extraction are (1) Morgan's reagent (glacial acetic acid buffered by means of sodium acetate at *p*H 4·8; this reagent is specially purified for the sensitive manganese test), (2) hydrochloric acid used in special instances for the extraction of iron and zinc.

The chemical tests used comprise well-known turbidity and colour tests, and assessment is made initially by eye. This enables the status of each element to be grouped into high, medium and low categories. These can be fixed more precisely by the use of the Lovibond comparator and standardized colour disks. Nutrient standards have been fixed for a range of economic plants, and a working knowledge of these is essential for accurate diagnostic work. Threshold values for deficiencies have been determined for the various nutrients, which generally coincide with the points of onset of visual signs of the particular deficiencies. In many instances tissue test values give a clue to an impending mineral deficiency or toxicity prior to the onset of visual signs.

A critical study has been made of the seasonal cycle of the extractable nutrients in a variety of crop plants grown under various manurial treatments, in order to determine critical sampling dates in the seasonal cycles of the various nutrient elements.

The correlations obtained between the tissue test results and the nutrient treatment, visual diagnosis and full chemical analysis of the foliage are good. On long-term manurial plots, soil analysis data are usually in accord with tissue test results; but survey work over wide areas has shown that agreement is not always close and further work is necessary.

The tissue test method has proved invaluable for rapid diagnostic work and has played an important part in resolving nutrient disorders in farm and garden crops. It should also be of value in ecological studies and in determining the distribution and translocation of nutrients in various plant organs.

The mineral-deficiency team at the East Malling Research Station, near Maidstone, Kent, the work of which was described by Dr. W. A. Roach, has concentrated mainly, but not exclusively, on leaf analysis and plant injection as preliminary methods of diagnosis. But to be of practical value a diagnosis must include a measurement of the effect of curative treatment on yield and quality of crop.

The analytical method is based on a comparison of leaves from unsatisfactory plants with corresponding leaves from plants that are satisfactory from the growers' point of view. At least six elements (iron, manganese, zinc, boron, copper and nickel) occurring in minute amount must be determined in the presence of relatively large amounts of the major nutrient elements. The special methods necessary for this purpose are being evolved. Plant injection methods make possible the treatment of a selected portion of a plant with any desired element, a similar neighbouring part being left untreated for comparison. The part may be of almost any size, from a single inter-veinal area of a leaf to a whole tree. The effect is seen in the course of a week or so.

The first big achievement of the injection method was to find a cure for various 'corky' troubles in apples. These caused the death of whole plantations in western Canada and rendered useless vast amounts of fruit there, in New Zealand and elsewhere. The proof by injection methods that the cause was boron deficiency led in a year to commercial methods of cure by spraying the trees and by applications to the soil. Serious deficiencies of copper in apple and pine trees in Australia and of manganese in cherries in Britain were diagnosed in a similar manner.

Plants are commonly deficient of more than one trace element at a time. Fruit trees in South Africa were deficient of both manganese and zinc. Many trees were dying and still more were barren. The cure of both deficiencies was necessary to restore the trees to full productivity.

Trace-element deficiency may not only accompany potassium deficiency, but also curing the trace-element deficiency seems sometimes to lead to a partial cure of the potassium deficiency, even without the addition of any potassium.

During the War, the methods were used for increasing the yields of arable crops. The cure of symptomless deficiencies of calcium and magnesium diagnosed in potatoes growing on freshly ploughed moorlands in Devon led to an increase of 3,000 tons of potatoes in the following season.

Multiple symptomless deficiencies of manganese, iron, zinc, boron, copper and nickel were proved to be of economic importance in the three crops tested, namely, potatoes, wheat and broad beans, in the marshlands of south Kent. The importance of complete diagnosis was illustrated by the fact that spraying potatoes according to diagnosis by symptoms, that is, with manganese, led to no increase in crop, whereas sprays containing manganese and zinc increased the crop from seven to eleven tons per acre, and spraying with all six elements diagnosed by injection led to still greater increases in crop.

The plant in absorbing essential mineral nutrients from the soil also takes up numerous other elements merely because they are brought into solution by the action of its roots, and since plant food is the basis of animal life, the same elements are found in animal tissues. Dr. H. H. Green (Veterinary Laboratory, Ministry of Agriculture, Weybridge) discussed trace elements in relation to the health of livestock.

If an element is found to be locally concentrated in some particular tissue, as, for example, iodine in the thyroid gland, the tendency is to assume a function for it, although it may be long before precise knowledge of that function is gained; but when the quantity of the element is not only exceedingly small but also is distributed throughout the tissues with no known sites of predilection, the impulse is to treat its presence as fortuitous until some instance of apparent absence is met in the form of an obscure deficiency disease, such as the 'pining' of lambs caused by lack of cobalt, or until the effects of unusual excess are shown in the form of a toxicosis such as the 'teart' of cattle in Somerset caused by excess of molybdenum.

Many of the trace elements found in living tissues are apparently inert; for example, nickel, although always present in soil-grown vegetation, does not appear to be an essential animal micro-nutrient, and relatively large amounts are harmless to animals. Some are important to plant physiology but of little consequence in animal economy. Boron is a limiting factor in plant health but, if essential for animal life at all, the smallest amounts ever found in plants are sufficient in the sense that no boron-deficiency disease has ever been recorded in animals. Zinc is certainly required by both plants and animals, and in the case of the latter it is the metallic component of the enzyme 'carbonic anhydrase' found in considerable concentration in the red blood corpuscles and other tissues; but the quantities in plant food exceed animal requirements, and no naturally occurring zinc-deficiency disease has been encountered.

With other trace elements the position is reversed, and their significance in animal physiology is much greater than in plant economy. Cobalt, if of any significance in plants at all, is required in such small amounts that a pasture may be growing luxuriantly and yet induce emaciation and death in grazing ruminants; while selenium can be tolerated by growing plants in amounts which are exceedingly harmful to animals consuming them.

Trace elements of proved economic importance are: iodine, copper, cobalt, manganese, selenium, molybdenum and fluorine. Lead and arsenic are neither biologically essential nor absorbed through plant roots in quantities injurious to animals. As for arsenic, the danger of cumulative poisoning is much exaggerated. Substantial sub-toxic doses repeatedly administered to sheep are rapidly eliminated, and the amounts naturally present in oysters and flat fish, although well above the limit sanctioned by health authorities concerned with arsenic as a food contaminant, are consumed without detriment to human health.

Prof. F. G. Gregory, of the Imperial College of Science and Technology, opened the discussion. He said that the work of the Research Institute of Plant Physiology on the subject under discussion fell between the field-work described by Dr. Roach and the very fundamental work of Dr. Hill. Use is being made of Dr. Roach's injection methods to provide material on which could be studied the effects of trace elements on various physiological functions of the plant. A start is being made with manganese and the potato, and results so far obtained are encouraging.

Dr. W. G. Ogg, of Rothamsted Experimental Station, said that his experience suggested that Dr. Roach's conclusion, that symptomless deficiencies of economic importance are common, might well apply to nine fields out of ten.

COAL UTILISATION RESEARCH IN GREAT BRITAIN

On December 12, Mr. R. W. Foot gave the presidential address to the British Coal Utilisation Research Association, his last before the vesting date of the nationalization of the coal industry in Great Britain. This Association worked for eight years under the control of the Mining Association, which had contributed for maintenance during this period more than eight million pounds. The Mining Association had envisaged the development of a permanent institution, more particularly since the possibility of nationalization of the coal industry was recognized. In that event it was hoped that the National Coal Board would agree to take over the activities of the Association. In anticipation, and in order to prevent the slackening which might arise during a period of uncertainty as to the future, the Mining Association continued its financial support without reservation until the vesting day, January 1, 1947. The National Board has accepted the principle mentioned, and on that day stepped into the shoes of the Mining Association so far as the British Coal Utilisation Research Association is concerned, and was able to find the organisation in a state of full activity.

During its existence, most of which had been during a period of war, the Association concentrated on certain major operations of coal utilization. Mr. Foot, referring to the last three years, mentioned in particular the work of Mr. J. S. Hales on domestic coal-burning appliances—a subject touching almost every householder—and described it as a 'landmark' in space heating. So far as Great Britain is concerned, there is some justification for the term. In countries where colder conditions are common, people appreciate the advantages of dispersing available heat throughout their dwellings; in Britain, practice has led to the localization of warmth and its insulation from the rest. Efforts to cope with the effects have of necessity tended to be improvisations. The work of the British Coal Utilisation Research Association has shown how, by more rational design of domestic grates, the effective use of coal heat can be increased, and at the same time can be more widely dispersed through a dwelling. Such principles can be applied generally, and already appliances have been designed whereby a single unit fed by smokeless fuel can be made to serve a whole house. This may lead to a radical change in household practice.

On the industrial side, the use of coal in the generation of steam is the largest outlet; and was given pride of place. Priority was given to the so-called 'shell' boilers—the smaller fire-tube units in common use. Although everywhere in use, it was believed that familiarity had led to neglect in some respects; it was thought that carefully conducted research with modern resources would promote improvements in design and increases in efficiency. The work of a section of the Association under Dr. E. G. Ritchie has confirmed these anticipations. The larger water-tube boilers have been developed under more scientific conditions, mainly stimulated by the needs of electrical industry. In modern practice these encounter extremely severe conditions of operation. It has become a major problem to keep such plant in continuous service, owing to the destructive action of acid and other inorganic materials present in the products of combustion. The work of the Association has already made contributions to improve the 'availability' for service of large steam generators.

Mr. Foot referred to the 'down-jet furnaces', which arose from work done, during the War, on gas producers. It has led to the construction of a furnace no bigger than a filing cabinet, but capable of producing per hour 200 lb. of steam at 200 lb. pressure. It is thought that such a furnace may enable solid fuels to be used to operate gas turbines.

The Association prosecutes a considerable range of more fundamental scientific work under the direction of Dr. D. H. Bangham. For all these branches there is now a staff of three hundred of all grades, under the control of the director, Dr. D. T. A. Townend. To provide for the necessary accommodation of all kinds, the Association is carrying out at Leatherhead a very extensive programme of building and equipment. It is planned to cope effectively with the great problems of coal utilization which the future promises to bring.

H. J. HODSMAN

CHEMOTHERAPY

The Linacre Lecture, 1946, delivered by Sir Alexander Fleming, on "Chemotherapy, Yesterday, Today and Tomorrow" (Cambridge University Press, 1946. 2*s*.), has now been published. Opening his lecture with the warning that the title chosen was too ambitious and would require a series of lectures, Sir Alexander limited his remarks to chemotherapy of which he has had first-hand knowledge. He refuses to confine the meaning of the term 'chemotherapy' to the administration of chemical substances by way of the blood; he extends it to include any form of treatment which enables a chemical substance to exert directly an injurious effect upon bacteria. This definition includes antiseptic treatment, two cardinal principles of which are the avoidance of chemical substances which are too toxic to the host or to the tissues, and the effective diffusion of the therapeutic agent into the infected tissues. Discussing the antiseptic methods of Lister and the practice of asepsis which followed them, Sir Alexander demonstrates, by reference to experience gained during the First World War, how important it is that diffusion of the local chemotherapeutic agent into the infected area should occur and, by reference to the mode of action of Dakin's solution, how important is the drainage of the infected lesion by the exudation of fluid from it. Important also is the action of local chemotherapeutic agents upon the phagocytes which attack the bacteria. Sir Alexander's own work on this problem is well known, and he here shows how essential it is to consider the speed of action of the chemical substance on the bacteria and on the phagocytes respectively. If the phagocytes are killed by it before it kills or appreciably inhibits the growth of the bacteria, the tissues are left without one of their main means of defence.

Sir Alexander points out that scientific chemotherapy began with Ehrlich. He then discusses the aniline dyes, and thus comes to the sulphonamide of chrysoidine (prontosil), with which Domagk began the remarkable series of researches by many workers which have produced the sulphonamides now in use. The relative advantages and disadvantages of the sulphonamides are briefly indicated, and thus we come to the year 1940, when penicillin, discovered by Sir Alexander in 1928, four years before the first sulphonamide was prepared and seven years before Domagk demonstrated the effective antistreptococcal action of prontosil, became available in sufficient quantity to enable practical therapeutical tests of it to be made. It is now well known how Sir Howard Florey and his collaborators in Oxford and in the United States made penicillin available and demonstrated its remarkable properties. It is, Sir Alexander says, the most powerful chemotherapeutic drug yet produced, for it will inhibit the growth of *Staphylococcus* even when it is diluted eighty million times. Adding still further to the discoveries of this fertile recent period, Sir Alexander outlines the properties of gramicidin and tyrothricin, obtained by Dubos in 1939 from a soil bacillus, *Bacillus brevis*, and those of streptomycin, obtained from *Streptomyces griseus* by Waksman in 1943.

Finally, Sir Alexander discusses briefly the possible chemotherapeutic developments of the future. This part of his lecture will perhaps disappoint those readers who expect dramatic prophecies; but, if they are disappointed, they have only themselves to blame, for no man could correctly forecast what may develop from the many possibilities opened up by recent work. Sir Alexander ends with a plea for the establishment of a central Institute of Microbiology, in which all the work now being done could be co-ordinated. The Royal Society called for the establishment of such an institute in 1945. If, says Sir Alexander, we had had such an institute in 1928, when he discovered penicillin but lacked the chemical facilities to develop his discovery, we could have had all the benefits of penicillin much earlier. A small fraction of the money spent upon our national medical, veterinary and agricultural services would endow such an institute. It would be difficult to conceive a project more essentially humane or a better long-term investment for the relatively small funds required.

G. Lapage

FORTHCOMING EVENTS

Monday, February 10

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Dr. H. W. Thompson: "Infra-Red Absorption Methods for Gas Analysis".

Tuesday, February 11

Society of Chemical Industry, Plastics Group (joint meeting with the Faraday Society, at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Mr. G. Gee: "The Influence of Molecular Structure on the Elasticity and Tensile Strength of Rubber".

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. R. M. Chamney: "Development of Telephone Transmission over Lines in the last 40 Years".

Zoological Society of London (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. E. K. Rideal, F.R.S., and Dr. P. Johnson: "Colloids". (Subsequent lectures on February 18, 25 and March 4.)

Illuminating Engineering Society (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. J. S. Smyth: "The Brightness and Legibility at Night of Road Traffic Signs".

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Short papers on "Fluorimetric Analysis".

Sheffield Metallurgical Association (joint meeting with the Refractories Association of Great Britain and the Sheffield Branch of the National Association of Clayworks Managers, at Mappin Hall, Sheffield), at 7 p.m.—Mr. W. T. Hale: "A Statistical Sampling Plan for Refractory Products".

Wednesday, February 12

Institute of Physics, London Branch (at the Royal Institution, Albemarle Street, London, W.1), at 2.15 p.m.—Annual General Meeting. Symposium on "New Optical Materials".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. F. A. Freeth, F.R.S.: "Economic Reconstruction; 3, Materials".

Institute of Physics, Manchester and District Branch (joint meeting with the Sheffield Physical Society, in the Physics Department, The University, Sheffield), at 5.15 p.m.—Dr. C. Sykes, F.R.S.: "Physics and Steel Making".

Institute of Petroleum (joint meeting with the Royal Aeronautical Society, at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. C. G. Williams: "Fuel and Lubricants for Aero Gas Turbines".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. T. Harwood: "The Operational Characteristics of Modern H.V. Wood-Pole Lines".

Manchester Metallurgical Society (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. L. F. Pfeil: "Metals and Alloys for Service at High Temperatures".

Television Society (joint meeting with the British Kinematograph Society, at Film House, Wardour Street, London, W.1), at 7.15 p.m.—Mr. Marcus F. Cooper: "The Film in relation to Television".

Society of Dyers and Colourists, Northern Ireland Section (at the Queen's Hotel, Belfast), at 7.30 p.m.—Dr. T. Richardson: "The Abbot-Cox Process of Yarn Dyeing as Applied to Cotton".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in Psychology" (Speakers: Dr. E. B. Strauss, Dr. C. G. L. Pratt and Dr. J. Cohen).

Manchester Geological Association (at the Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester).—Dr. F. M. Trotter: "Structures in the North-Western Part of the South Wales Coalfield".

Thursday, February 13

Chemical Society (in the Chemical Department, The University, Woodland Road, Bristol), at 2.15 p.m.—Discussion on "Protein Chemistry".

Society of Dairy Technology (at the Imperial Hotel, Temple Street, Birmingham), at 2.15 p.m.—Dr. S. K. Kon: "The Effect of Heat-Treatment on the Nutrient and Chemical Properties of Milk and Milk Products".

Chemical Society (joint meeting with the Sheffield University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. Monteath Robertson, F.R.S.: "Bond Lengths in Aromatic Hydrocarbons".

Institution of Electrical Engineers, Installations Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. Widnall and Mr. R. Newbound: "Protective Finishing of Electrical Equipment".

Institution of Electronics, N.W. England Section (joint meeting with the Manchester Centre of the Illuminating Engineering Society, in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. H. Meyers and Mr. G. A. R. Tomes: "Recent Advances in Luminescent Materials for Electronic Devices".

Women's Engineering Society, Manchester Branch (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Members' Night—"Our Jobs and Problems".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Dr. H. Davis: "Some Chemical and Pharmaceutical Aspects of Anæsthesia".

Royal Photographic Society (joint meeting of the Scientific and Technical Group and the Colour Group), at 7 p.m.—Mr. Percy W. Harris: "Practical Colour Processes" ("How It Works in Colour Photography", 4).

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. H. P. Staudinger: "Polymer Chemistry".

Chemical Society, Manchester Section (joint meeting with the Local Section of the Royal Institute of Chemistry, in the Chemistry Department, The University, Manchester), at 7.30 p.m.—Prof. M. Stacey: "Some Aspects of the Chemistry of Fluorocarbons".

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Prof. H. Brindle: "Penicillin".

Friday, February 14

British Electrical and Allied Industries Research Association (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11.30 a.m.—Annual General Meeting.

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. P. R. Masheder: "Lubrication—its Application and Control in the Textile Industry".

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. D. H. Hewitt: "Further Developments in Styrene Co-Polymers".

Physical Society, Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. L. V. Chilton, Dr. H. H. Hopkins and Mr. J. S. Preston: "Physical Optics and Technical Applications"; Dr. W. S. Stiles: "Visual Photometry, Colorimetry and Physiological Optics" (Reports on the Réunion d'Opticiens, Paris, October 1946).

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. H. H. Plaskett, F.R.S.: "Astronomical Spectroscopy". Annual General Meeting.

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. G. Eyssen: "Polyvinyl Chloride and its Co-Polymers".

Paper Makers' Association, Northern Division (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Dr. W. W. Barkas: "The Sorption and Swelling of Cellulose under Naturally Imposed Restraints".

Textile Institute, Bolton Branch (at the Municipal Technical College, Bolton), at 7.30 p.m.—Mr. F. Scholefield: "A Service by the Dyer to the Manufacturers".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. F. Ian G. Rawlins: "Natural Science and the Fine Arts".

Saturday, February 15

Biochemical Society (at the London School of Hygiene, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Relation of Optical Form to Biological Activity in the Amino-Acid Series".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Lecturer in Physics at the Leeds College of Technology—The Director of Education, Education Department, Calverley Street, Leeds 1 (February 15).

Lecturers and Teachers in Chemistry and Metallurgy (Graduate), Mechanical Engineering (Graduate), Civil and Structural Engineering (Graduate), and Automobile Engineering, at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick (February 15).

Senior Lecturer in Mathematics in the Training Department—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (February 15).

Lecturer in Chemistry—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex (February 17).

Assistant Agricultural Economist (male)—The Secretary and Registrar, The University, Bristol (February 18).

Lecturer (part-time) in Psychology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8 (February 20).

Lecturer or Assistant Lecturer in Electrical Engineering—The Secretary, King's College, Strand, London, W.C.2 (February 21).

Senior Assistant Physicist in the Department of Physics Applied to Medicine—The Dean, Middlesex Hospital Medical School, London, W.1 (February 28).

Lecturer in Geography—The Registrar, The University, Manchester 13 (February 28).

Chemist to be trained for Spectrographic Analysis—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (February 28).

Lectureship in Materia Medica and the Robert Pollok Lectureship in Pharmacology—The Secretary of the University Court, The University, Glasgow (February 28).

Educational Psychologist—The Director of Education, Education Office, College of Technology, Belfast, endorsed 'Educational Psychologist' (February 28).

Director of Research—The General Secretary, British Hat and Allied Feltmakers' Research Association, 12 St. Peter's Square, Stockport, Cheshire (March 1).

Lecturers (2) in Chemistry (one with special qualifications in Organic Chemistry, and the other in Physical Chemistry)—The Registrar, The University, Reading (March 3).

Technical Officer to undertake technical service and liaison visits to member firms of the Association—The Director of Research, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon (March 8).

Lecturer in Botany at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (March 10).

Chair of Physics—The Principal, Heriot-Watt College, Edinburgh (March 10).

Official Fellow and Tutor in Chemistry—The Principal, Jesus College, Oxford (March 15).

Harrison Chair of Mechanical Engineering—The Registrar, The University, Liverpool (March 15).

Chair of Physiology tenable at Bedford College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 25).

Chair of Physiology tenable at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 25).

Chair of Political Science in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (April 7).

Entomologist with a special interest in and knowledge of the coleoptera, and an Entomologist with a special interest in and knowledge of the hymenoptera—The Director, Imperial Institute of Entomology, 41 Queen's Gate, London, S.W.7 (June 1).

Laboratory Steward for Electrical Measurements Laboratory—The Head of the School of Engineering, The Polytechnic, 309 Regent Street, London, W.1.

Graduate (young, female) with a degree in zoology for research in anthropometric studies—The Secretary, The University, Edmund Street, Birmingham 3.

Teacher of Physics and Mathematics at the Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster.

Lecturers in Mathematics, Physics and Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Laboratory Assistants (2, male) for work in the Medical Research Council Unit for Bacterial Chemistry—The Secretary, Unit for Bacterial Chemistry, Lister Institute, Chelsea Bridge Road, London, S.W.1.

Chemical Engineer (graduate) for furnace research and development—The Assistant Secretary, British Coal Utilisation Research Association, 13 Grosvenor Gardens, London, S.W.1.

Research Officer with good qualifications in physical chemistry and with research experience, a Junior Research Officer, and a man with the Higher National Certificate in Physics (or equivalent qualification) to assist with the development, calibration and servicing of industrial electrical instruments—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Lecturer in Applied Mechanics at the Royal Naval College, Greenwich—The Director, Education Department, Admiralty, Whitehall, London, S.W.1.

Professorship of Pure and Applied Mathematics in the Royal University of Malta—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

Assistant Controllers of Telecommunications (Engineering), and Assistant Controllers of Telecommunications (Wireless), in the Telecommunications Department of the Malayan Union—The Director of Recruitment, Colonial Office, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scottish Reconstruction Committee. Bulletin No. 16: The Raw Materials of Scotland—Peat. By A. G. Clement and Robert H. S. Robertson. Pp. 6. (Glasgow: Scottish Reconstruction Committee, 1946.) 3*d*. [2110

Department of Scientific and Industrial Research: Fuel Research. Technical Paper No. 53: Smoke and its Measurement—The Correlation of Optical Density with the Nature and Quantity of Smoke from a Hand-fired Lancashire Boiler. Pp. iv + 20. (London: H.M. Stationery Office, 1946.) 6*d*. net. [2110

Hull Bulletins of Marine Ecology. Vol. 3, No. 17: The Plankton of the North Sea in relation to its Environment, Part 1, The Hydrological Background in the Southern North Sea, 1930–37. By Dr. C. E. Lucas and K. M. Rae. Pp. 33. (Hull: University College, 1946.) 3*s*. 6*d*. [2110

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 19: The Feeding Value of Seaweeds. By B. J. Senior, P. Collins and M. Kelly. Pp. 273–291. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946.) 2*s*. [2110

Royal Cancer Hospital Mechanically Sorted Punched Card Index System. Compiled by Dr. D. W. Smithers, K. M. H. Branson and Dr. H. O. Hartley. Pp. 102. (London: Royal Cancer Hospital, 1946.) [2410

Scientific and Technical Aspects of the Control of Atomic Energy. Pp. v + 42. (London: H.M. Stationery Office; Lake Success, N.Y.: United Nations Department of Public Information, 1946.) 1*s*.; 25 cents. [2410

Apparent Places of Fundamental Stars, 1947: containing the 1535 Stars in the Third Fundamental Catalogue (FK3) of the Berliner Jahrbuch. (Published by order of the Lords Commissioners of the Admiralty.) Pp. xxxii + 538. (London: H.M. Stationery Office, 1946.) 42*s*. net. [2810

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 17: On a Recent Bogflow in Meenacharvy Townland, Co. Donegal. By D. W. Bishop and G. F. Mitchell. Pp. 151–156. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946.) 1*s*. [2810

Universities Quarterly. Vol. 1, No. 1, November. Pp. 112. (London: Turnstile Press, Ltd., 1946.) 5*s*. [2810

Russian Studies. Edited by Dr. Louis Segal. (Published bi-monthly.) Vol. 1, No. 1. Pp. 24. (London: Collet's Holdings, Ltd., 1946.) 1*s*. [2910

You and Your Children: B.B.C. Talks by a Woman Medical Psychologist. Pp. 32. (London: H.M. Stationery Office, 1946.) 6*d*. [2910

Ministry of Agriculture and Fisheries. Bulletin No. 133: Apples and Pears. Pp. vi + 119 + 17 plates. (London: H.M. Stationery Office, 1946.) 2*s*. 6*d*. net. [3010

Other Countries

Annals of the Observatory of Lund. No. 8: Latitude and Longitude Determinations in Eastern Turkistan and Northern Tibet derived from Astronomical Observations. By Nils Ambolt. (Reports from the Scientific Expedition to the North-Western Provinces of China under the Leadership of Dr. Sven Hedin: The Sino-Swedish Expedition, Publication 6, II. Geodesy, 1.) Pp. 143. No. 9: A Study of External Galaxies with special regard to the Distribution Problem; Researches based on a Catalogue of 4666 Galaxies. By Anders Reiz. Pp. 84 + C94. No. 10: A Morphological Investigation of some Near Galaxies with regard to the Lengths and the Form of their Arms, their Inclinations and their Symmetry Properties. By Carl-Gustav Danver. Pp. 192 (8 plates). (Lund: Astronomiska Observatorium, 1938–1942.) [3010

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THE FOOD AND AGRICULTURE ORGANISATION

RELATIVELY little publicity has been given in the Press or elsewhere to the activities of the Food and Agriculture Organisation, though from the various reports that it has issued a great deal of essential preliminary work has evidently been accomplished. A staff of highly competent experts has been temporarily on loan from Government departments and other international bodies for the purpose, though now a nucleus of permanent personnel is established, to which recruitment is to be made on as broad a geographical basis as possible. At the time of its inauguration in November 1945, responsibility for dealing with the immediate post-war world shortage of food was in the hands of international organisations such as the United Nations Relief and Rehabilitation Administration, the Combined Food Board and the Food and Agriculture Sub-committee. By the time that these bodies were due to go out of existence under the arrangements already made, it was hoped that the worst of the food shortage would be over, and that the new authority would start to develop its plans under conditions approximating to those of 1939. Its first task was, therefore, to assess the pre-war position in as many countries as possible as a guide to working out future policies. During the winter of 1945–46, however, serious deterioration in the world's food supplies set in, and following an appeal for help, the Director-General agreed that the Food and Agriculture Organisation should undertake responsibility for relieving the situation. A special meeting was called at Washington in May 1946, at which recommendations were made to Governments as to the best use of the 1946 harvest and the ways in which still larger harvests could be secured in 1947. Allocation of foodstuffs, based on information and statistics provided by the Organisation, was delegated to a new agency, the International Emergency Food Council. An inquiry was then called for to ascertain the adequacy of existing international institutions to meet long-term problems of production, consumption and distribution, including surpluses.

Two important publications were the outcome of this meeting, "World Food Survey" and "Proposals for a World Food Board"*. The first is a study of the pre-war food consumption figures for seventy countries, comprising 90 per cent of the world's population. It includes targets drawn up by nutrition experts with the view of providing everyone with an adequate balanced diet, together with a budget of world requirements in 1960 if such targets are to be reached, due allowance being made for population increase in the meantime. The figures are inevitably incomplete, but are probably accurate to within 5 per cent for countries with a high calorie intake and 10 per cent for areas where the consumption is low. The extent of the malnutrition can be estimated from the finding that more than half the world's population had a pre-war calorie intake of only 2,250 a head a day; less than one third had available 2,750 or more calories. The deficiency was greatest in Central America and most of Asia, whereas the high-calorie groups occurred chiefly in North America and European countries; though it is realized that average figures inevitably conceal sharp variations owing to uneven distribution.

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* Food and Agriculture Organisation of the United Nations. First Annual Report of the Director-General to the F.A.O. Conference. Pp. iv+45.
World Food Survey. Pp. 39.
Proposals for a World Food Board. Prepared for submission to the Second Session of the Conference of the Food and Agriculture Organisation, Copenhagen, Denmark, 2 September, 1946. Pp. iii+12.
(Washington, D.C.: U.N. Food and Agriculture Organisation, 1946.)

Further, the proportion of the various types of food yielding a similar total in calories may depend on national diet. Denmark and New Zealand, for example, are both countries with a high average food intake and a well-balanced diet; but though their consumption of cereals was equally low and that of milk equally high, wide differences were shown in regard to intake of animal protein and fat. Abundance of supplies and adequate purchasing power, however, resulted in a satisfactory diet in each case. In some of the countries in the low-calorie group, such as Java, the malnutrition was worse than the total figures suggest, since the proportion of cereals consumed was too high and the protein and fat consumption quite inadequate to maintain health. As a basis on which to work, estimates of the various foods needed by the world in 1960, if the calorie intake per head per day in the low-calorie groups is to be raised to 2,550–2,650, have been put forward by nutrition experts. The proportions of the different types of food comprising this total are roughly indicated, as the primary aim is to improve the balance between the various components of the unsatisfactory diets rather than attempt to alter the habits of any country.

For such a target to be achieved, production will need to be raised considerably, though the actual increases required vary widely with the different commodities, ranging from 12 and 21 per cent respectively in the case of sugar and cereals, to 100 per cent for milk and 163 per cent for fruit and vegetables. Increased production in its turn implies improvement in agricultural methods. More fertilizers and machinery will be wanted, irrigation and drainage schemes must be carried out, and deteriorated areas reclaimed. The application of science to agriculture, however, does not necessarily provide the solution; it may even create its own problems, as, for example, the accumulation of local surpluses, so that proper distribution becomes the major difficulty. Economic and social changes are also called for, such as the large-scale development of industry and trade, educational services, and some machinery for supplying credit to farmers. Positive action on an international scale to plan and organise production, marketing and finance would be needed to implement these recommendations, and in a further report the formation of a World Food Board was proposed. This body was envisaged as a central authority, empowered to hold reserve stocks of the more important commodities, to provide funds for financing the disposal of surpluses, and to co-operate with organisations concerned with international credits for industrial and agricultural development. Later discussion, however, rejected the scheme i this form, and proposals of an alternative natu were put forward.

In September 1946, the second meeting of th Food and Agriculture Organisation was held Copenhagen. Five new member nations we admitted, bringing the total to forty-seven. Th principal concerns of this conference were to apprai the Organisation's work during the previous month and to make a start with the major problems of long-range world food policy. One special featu was the approval of the report of the Commission t Greece, which at the request of the Greek Gover ment had carried out a survey of the agricultur forestry and fisheries of the country, and mad recommendations for future improvements an development. It was the first of this type of enter prise undertaken by the Organisation, though th extension of such services to other countries, a requested, is likely to be a feature of its activities i the future.

Though the Copenhagen conference did not los sight of the fact that there is still an urgent need fo maximum food production, avoidance of loss during storage and continued controls and economies in th use of all basic foods, the chief interest was naturally centred on the long-range programme. For this purpose a Preparatory Commission was set up to develop proposals for inter-governmental action to prevent the occurrence of both shortages and surpluses o food and other agricultural products, and, in particular, to consider the proposal already put forward for a World Food Board. The Commission consisted of representatives from sixteen member nations, three non-member nations with major or specialized food resources also being asked to participate. In addition, co-operation was invited from various inter-governmental organisations connected with trade, health and finance. The principal findings of this Commission have now been announced. Though entirely in agreement with the essential features of the plan put forward by Sir John Boyd Orr in his proposal for a World Food Board, it has recommended that, in place of an international authority itself holding reserves of food and purchasing power, co-operation should be worked out between the nations on a voluntary basis. Reserves of food should be built up nationally, but they should be operated internationally; orderly marketing policies should be framed and price-levels for a term of years fixed by international agreement. A World Food Council representing eighteen nations is suggested, which would work in close liaison with the Food and Agriculture Organisation, and meeting if required at intervals between the conferences of the latter. The proposals fit into the general scheme of the United Nations Organisation, and allow of close co-operation with existing agencies, among which the International Bank may be specially mentioned.

A policy of expansion is the keynote of the programmes suggested, both as regards food production and the development of industry and social services in rural areas. The carrying out of the proposals, however, depends on the various Governments conerned ; for they will have to provide the necessary acilities and co-operation if the aims of the Food nd Agriculture Organisation are to be realized, and dequate food, at a fair price, be made available to ll. The scientific and technical views, based on a ritical examination of the data available, have been et out ; it is now the task of the statesmen of the world to frame their policies to fit the facts of the ituation.

EARLY SURVEYS IN INDIA

Historical Records of the Survey of India
Vol. 1 : 18th Century. Collected and compiled by Colonel R. H. Phillimore. (Published by order of the Surveyor General of India.) Pp. xx+416+21 plates. (Dehra Dun : Survey of India, 1945.) 30 rupees ; 47*s*. 3*d*.

AT a time when Britain is trying to terminate her responsibility for the government of India, it is well that her services to that country should be placed on record. And there is no field of activity in which the British are better entitled to take pride in what they have done for India than that of surveying ; for the Survey of India has built up a reputation for enterprise and efficiency which is unsurpassed. The achievements of the Survey of India are for the most part well known, but not all of them have been placed on record. Regular publication of reports of its work only began some years after the Sepoy mutiny of 1857, and little information is available of the survey work done before that time. The Survey is now planning to fill in this blank.

Fortunately, the blank is not due to any failure to keep records of what was done. On the contrary, it seems to have been due rather to a superabundance of records which are so voluminous (those of the Great Trigonometrical Survey at Dehra Dun alone comprise seven hundred volumes) that, apparently, it has not been possible previously to find anyone who could give the time needed for their examination. This difficulty has now been surmounted. Colonel Phillimore, an officer of the Survey of India who retired from the Service a few years before the War, offered to undertake the task ; and, in spite of the interruption caused by the War, has carried it out with praiseworthy speed and thoroughness. This volume is the first of a series which will embody the results of his work. It deals with a period which the author calls "the age of romance and adventure in India". The next one "will cover a short but important period, 1800–1815, during which Colin MacKenzie brought regular organisation and system to the surveys of the Madras Presidency, and William Lambton laid the foundations of the trigonometrical survey". A third volume, "1815–1830, will tell of the co-ordination of all surveys under one Surveyor General of India, the extension of Lambton's survey . . . to be the Great Trigonometrical Survey of India . . . of the birth of a Revenue Survey Department . . . and the start of the Great Atlas of India . . . based on the G.T. Survey". Presumably the series will eventually be completed by a fourth volume covering the remaining thirty years or so until the date when the publication of regular reports began.

This volume opens with a short chapter entitled "General Narrative", which starts in the year 1719 when "a Jesuit missionary, Father Boucher, sent home to Paris a rough map of India and some sketches from which Bourgignon d'Anville published his first map of India in 1739", and ends at the capture of Seringapatam "with Mackenzie making preparations for the first great topographical survey, and Lambton yet to propound his scheme for a trigonometrical survey to extend right through the peninsula".

After the general narrative, each Presidency is dealt with in turn. Bengal gets three chapters, Madras two, and Bombay one. The surveys recorded were all the work of individuals, for this was before the days of systematic State-controlled survey work, which did not begin, even in Great Britain, until nearly the end of the century. Some of the surveyors worked on their own initiative, others did their work under orders, when an opportunity to survey some route or district happened to occur. This being the case, it is not possible to present the record as a continuous narrative. The chapters dealing with the surveys of the Presidencies are more like a catalogue of work done, but are enlivened by extracts from the journals kept by the surveyors ; extracts which are interesting in themselves, at any rate to those who have an interest in India, and, together, give a good impression of the conditions under which the surveyors had to work. Of more general interest are the chapters on Himalayan exploration, and on the preparation of atlas maps. It seems that the question of the identity of the Tsang-Po River of Tibet with the Brahmaputra of India, which was to cause so much discussion and controversy among geographers a century or so later, had been virtually settled by eighteenth-century explorers.

Most of the surveys were route sketches, generally compass traverses with distances measured by 'perambulator'. The Madras pattern perambulator, said to be the best, had a wheel nearly 7 ft. in diameter. "It was difficult to manage in a high wind, requiring two men to work it," and, worse still, it was always breaking down ! District maps were made by compiling route sketches, often a matter of some difficulty, for few of the sketches can have been accurate, and there were few well-fixed points. Many surveyors took observations for latitude to check their work, but the difficulty of determining longitude, until chronometers came into use towards the end of the century, limited the value of these fixes.

The records are not confined only to surveys ; there is a chapter on "Professional Methods" and another on instruments, while four or five chapters are devoted to personnel and conditions of service. The record concludes with a chapter on "Inhabitants and Officials" which supplements the 'general narrative' at the beginning of the book.

The account of the surveys is followed by nearly a hundred pages of "Biographical Notes" on the surveyors. These are arranged in alphabetical order and include references to more than two hundred individuals. If half a dozen of those who made outstanding contributions to the mapping of India were to be picked out, the choice might fall on the following : Alexander Dalrymple, Hydrographer to the E.I.C. 1779–1808 ; Robert Kelly, killed in a duel in 1790, and described as "a striking instance of a zealous and practical surveyor who was at the same time a distinguished soldier" ; Colonel Colin MacKenzie, Madras Engineers, Surveyor General, Madras, 1810–15, and Surveyor General, India, 1815–20 ; Major James Rennell, Bengal Engineers, Surveyor General, Bengal, 1767–77, an ancestor of the present Lord Rennell, who, after a life packed with work, hardship and adventure, including wounds which nearly ended his life at the age of twenty-four, lived to be nearly ninety, and is buried in Westminster Abbey; Lieut.-General Charles Reynolds, Surveyor General, Bombay, 1796–1807; and finally Michael Topping, Surveyor and Astronomer, Madras, 1785–96, who is described as "the most intriguing figure amongst all our surveyors of the 18th century".

The volume is illustrated with twenty-one plates, fifteen of them extracts from maps of the period, and four portraits of surveyors who made noteworthy contributions to the mapping of the peninsula.

M. N. MacLeod

FRENCH BOOKS ON AERONAUTICS

Considérations sur la conduite et l'exploitation des essais de qualités de vol des avions

Par Maurice Cambois. (Les essais en aéronautique, 1.) Pp. xv+126. (Paris: Libr. Dunod, 1945.) 240 francs.

Les essais de performances en aéronautique

Par Francois Hussenot. (Les essais en aéronautique, 2.) Pp. x+151. (Paris: Libr. Dunod, 1946.) 455 francs.

Les vibrations sur les avions

Calculs, essais, remèdes. Par Maurice Berthaume. (Guide du calculateur d'avous.) Pp. xii+79. (Paris: Libr. Dunod, 1946.) 275 francs.

THE first two of these books are respectively the first and second of a series entitled "Tests in Aeronautics". Other books in the same series in preparation or about to be published are: "Kinematics of Aircraft: Instruments in Flight Testing"; "The Technique of Piloting for Flight Testing"; "Engine Testing in Flight"; "Flight Testing of the Radio Equipment".

The first book covers the study of static stability and the damping of small-amplitude oscillations. It is the result of pioneering work at Villacoublay, before the War, of a small group of scientific workers to which M. Cambois belonged. Most of the experimental work described was made before the War, which postponed the publication of the book. Because of the progress made in aeronautics during the War, some of the technique described appears already out of date, and no doubt the book is not always representative of present-day French technique. The book is in two parts. In the first, methods and results are discussed, and the second contains the mathematical treatment which is the basis of the flight tests. Longitudinal and lateral stability are treated separately, and it is interesting to note that stability is considered strictly from the pilot's point of view, and is therefore assessed by measuring stick forces or movements only instead of the actual control movements as is more the practice in Great Britain. Deformations in the control circuit and of the aircraft structure under load are therefore embodied in the measurements and are an unknown portion of them. The rapidly increasing importance of aero-elasticity effects with speed has long made a knowledge of at least their order of magnitude essential. Also comparison with wind tunnel tests is more difficult. The various factors influencing stability are discussed, and from them a typical flight test programme for a prototype is deduced. The investigation of small-amplitude oscillations in flight is purely qualitative and is limited to checking that the oscillations are damped. The study of the controls is also qualitative and is limited to checking that the controls are adequate for all the normal evolutions of the aircraft. The book unfortunately does not contain a description of the instruments used, as these are to be the subject of another book in the same series.

"Performance Tests in Aeronautics", by F. Hussenot, deals with measurements associated with the ordinary evolutions of aircraft, namely, take-off and landing, climbs, level speeds, range, etc. In the first two chapters, general methods are discussed, and the particular methods favoured by the French are gone into in detail, except for the description of the instruments for the same reason as before. The methods described involve the extensive use of cameras both on the aircraft and on the ground. These, together with accelerometer and speed measurements, make the reconstruction of flight paths possible. Similar methods are used even for the measurement of level speeds at altitude with the help of local survey maps. Flight measurements on the power plant are then discussed, and the author points out once more the need for reliable and simple torque and thrust meters. The measurements actually made are those of airscrew r.p.m., boost pressure, various temperatures and fuel consumptions. All measurements are recorded simultaneously and centrally on photographic paper. The reduction of flight measurements to the standard atmosphere is gone into in detail, and various ways of presenting the data are suggested. Stress measurements in flight are briefly surveyed, but these have been found too difficult to be included in routine tests. The last chapter deals with special performance measurements, and these include measurements on flying-boats, autogyros, jet-propelled aircraft, towed gliders, etc. The book ends with some appendixes on sign conversions, reductions of fuel consumption measurements to the standard atmosphere, range measurements and on the use of logarithmic diagrams for propellers.

"Aircraft Vibration", by M. Berthaume, gives an elementary account of methods for the theoretical determination of the natural vibration frequencies of aircraft components and of the wing flexure-torsion flutter speed, and of the experiments required in connexion with them.

The theoretical methods make use of the concept of 'semi-rigidity' which has been adopted as the basis of flutter calculations in Great Britain. The usual method used in Britain for the theoretical determination of natural frequencies of vibration consists in replacing the aircraft component (or the complete aircraft) by a discrete mass system. The method given in this book, which replaces the wing, for example, by a semi-rigid structure possessing only two degrees of freedom in flexure and torsion, will give only the fundamental frequencies in flexure and torsion, the accuracy being dependent on the choice of deflexion modes which do not differ too greatly from the modes occurring in practice. It is also important to obtain a reasonably close estimate of some of the overtone frequencies; a larger number of degrees of freedom would be required in the calculations for this purpose. The values given for the inertia coefficients which occur in the equations of § 10 are not strictly correct. For a semi-rigid body it is not correct to take the moments about the root; the correct expressions are obtained from the principle of virtual work. (The quantities f_1, f_2 in the expressions for the inertias are then replaced f_1^2,

$_1f_2$; f_2^2, and the two mutual inertia coefficients J_1, J_2 then become equal.)

The treatment of the flutter problem is far from satisfactory, since the aerodynamic damping coefficients are completely ignored. The so-called flutter peed found by the method given may bear little relation to the true flutter speed, and will always be higher. The discussion on flutter is limited to flexure-torsion wing flutter, which involves two degrees of freedom only. Although methods for preventing control surface flutter by mass-balancing are reviewed, the determination of control surface lutter speeds is not discussed.

A brief account is given in Chapter 4 of methods of performing resonance tests. The wing is forced to vibrate by means of rotationary exciters; it is preferable to use linear-exciters consisting of a pair of out-of-balance masses, to avoid exciting lateral motion. The possibility of anti-symmetrical vibration has not been considered; by exciting at one wing tip only, as is recommended in this book, the resulting vibration will be a mixture of symmetric and anti-symmetric vibration. The piezo-electric detectors which are used have been found unsatisfactory in Britain, since the range of amplitude for which they give a satisfactory response is limited.

ROSIN AND ITS PRODUCTS

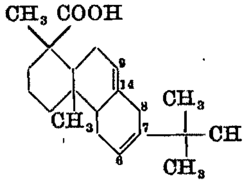
Produits résineux

Gemmes, colophanes et dérivés. Par Dr. René Lombard. (Matériaux de synthèse.) Pp. xv+316. (Paris: Libr. Dunod, 1946.) 385 francs.

ALTHOUGH France is the second largest producer of rosin and turpentine, she has practically no literature on the subject. Dr. R. Lombard, who has studied under Prof. DuPont and Prof. Brus of the Bordeaux Institut du Pin, seeks to remedy the defect, for the benefit of the many technical users of rosin and products from it. He has collected and correlated the available information and deals particularly with the fundamental study of pine rosin acids.

This book comes at a time when chemists are more occupied with synthetic resins than natural resins, and emphasizes the relative simplicity of the former compared with the latter. It also brings to mind Ruzicka's suggestion that known terpenes could be built up from isoprene. The book draws on "Die Harze" of Tschirch and Stock; but, as the author warns us, does not have the botanical background of that classical work. The book gives a good account of the brilliant researches of Ruzicka and other workers, such as Prof. R. D. Haworth, which have done much to elucidate the structure of many of the rosin derivatives.

The chapter on abietic acid is good, and so is the description of the work on the elucidation of the structure of *l*-pimaric acid and *d*-pimaric acid. It is unfortunate that these names are retained, since the two acids are not optical isomers. Dr. Lombard prefers the following formula for abietic acid



because it accounts for the direct transformation of *l*-pimaric acid to abietic acid, while the normally accepted Fieser formula, which has the double bond between the 7 and 8 carbons, necessitates an intermediate step. The generally accepted formula, however, is adopted throughout the book.

Dr. Lombard has given us a very useful volume. Rosin is the cheapest and most abundant source of organic acids, and rosin acids, because of their salt-forming properties, find industrial uses in the soap and paper trades; their ester-forming properties render them valuable in the varnish trade. This book is therefore helpful to many engaged in these industries. The bibliographies at the end of each chapter are very useful, but the reader will find the lack of an index in the book somewhat annoying.

INDIAN FOLK-TALES

Folk-Tales of Mahakoshal

By Dr. Verrier Elwin. (Specimens of the Oral Literature of Middle India: Published for "Man in India".) Pp. xxv+523. (London: Oxford University Press, 1944.) 25*s*. net.

DR. VERRIER ELWIN has rendered a great service to anthropology in his monographs upon the peoples of the Central Provinces. In this volume he sets out to "preserve for English-speaking readers specimens of *their* oral literature". The phrase is not very happy. His purpose is scientific, for he censures certain works as being "published purely for entertainment". Yet he admits that he has published this volume without reference to Thompson's "Motif-index of Folk-Literature". It is therefore not surprising that the reader finds his chapter-headings hard to follow. For example, "the boy whose brother was a bull" theme appears both under "The Quest for Love and Treasure" and "The 'Magic Articles' Motif". Moreover, Dr. Elwin does not attempt to distinguish between the basic folk-tales of the several peoples he reports and the ancient and very highly finished wares of India's professional story-tellers. There are several traces of the purely literary and foreign Persian "Sad Hikayat" among these stories.

It would have been helpful if the author had given the name and some details of each of his informants. The usefulness of the book as a crude quarry of material is also diminished by the absence of the dialect terms. On p. 397 the original is quoted but not translated. Elsewhere, no attempt is made to provide a clue to the many obscurities such tales necessarily contain. The "Hare Ram" on p. 383 is quite unintelligible, while on p. 386 the glossary gives correctly *Shorea robusta* for the sarai tree of the story, which in the text is later specifically called a mango. On p. 211 rather abrupt reference is made to a catapult, which must be modern, for the catapult is nowhere else indigenous in India. The glossary might well have been expanded; for example, no reference is made to the well-known caste of pack-carriers, the Lamani (not, surely, Lamana ?), or to the interesting examples of Acts of Truth, which occur more than once. The bibliography contains no entries from the Royal Anthropological Institute's journal *Man*. Some of the author's comments upon certain quite unpretentious works would seem to be a little more acid than is called for.

K. DE B. CODRINGTON

THE PAN-AFRICAN CONGRESS ON PREHISTORY

THOSE who are not well acquainted with the fields of prehistory and allied studies will scarcely be aware of the great developments which have recently taken place in these subjects in different parts of Africa. It is true to say, however, that as the result of the enthusiastic work of archæologists, palæontologists and geologists throughout that Continent, a vast mass of evidence has now been collected having the most important bearing on fundamental problems of human evolution and the development of early cultures. But much of this evidence has been assembled independently in widely separated regions of the Continent, and for some time it has been recognized that further progress might be seriously impeded if the relative isolation of prehistorians in different parts of Africa were to continue. It was mainly for this reason that the idea of a Pan-African Congress on Prehistory was conceived and put into effect by Dr. L. S. B. Leakey, curator of the Coryndon Memorial Museum in Nairobi. In spite of transport and other difficulties, the Congress has met with very considerable success, for it was attended by more than sixty delegates representing all the African territories as well as many European countries.

The Pan-African Congress was formally opened in the Town Hall of Nairobi on January 14 by the Governor of Kenya, Sir Philip Mitchell, and the proceedings were broadcast. The Abbé Breuil was unanimously elected president of the Congress, and Dr. R. Broom the vice-president. Meetings were held in the Town Hall and were continued from January 14 until January 23, during which many papers were read and discussed. For convenience, the business of the Congress was divided into three sections: (1) Geology, Climatology, and General Palæontology (chairman, Prof. A. L. du Toit); (2) Archæology (chairman, Dr. L. S. B. Leakey); and (3) Human Palæontology (chairman, Prof. R. Dart).

In the first section, interest tended to be focused largely on chronological problems, and particularly on the relation of early man in Africa to climatic fluctuations, faunal sequences, relative changes of land- and sea-levels, and geological events such as the formation of the Great Rift Valley. The Quaternary fauna of the African Continent was discussed in illuminating papers by Prof. C. Arambourg and Dr. B. S. Cook, and interesting points in the faunal correlation between Pleistocene Africa and Ceylon were made by Prof. P. Deraniyagala. The problem of the Plio-Pleistocene boundary was raised by Prof. F. Zeuner—an important problem in any attempt at a correlation of quaternary sequences in the African Continent with those in other parts of the world. Other papers dealing with the relation of geology to prehistory included a study of the development of the Sudan Plain in the quaternary by Mr. G. Andrew, a discussion of the recent physiographic history of the Lower Nile Valley in relation to pluvial oscillations in Abyssinia by Dr. S. A. Huzayyin, and an account of the high-level beaches of the Tanganyika lakes by Dr. D. R. Grantham. An interesting symposium was also held on the relation of pleistocene marine terraces to Stone Age cultures, with the main contributions by the Abbé Breuil, Prof. Zeuner and Dr. A. Ruhlmann, and a general discussion was held on the whole question of the Pleistocene in Africa with special reference to the dating of deposits and the devising of a unified terminology for describing the Pluvial Periods.

In the section on archæology, a number of delegate from different parts of Africa contributed an accoun of Palæolithic culture sequences in their own particular areas as a preliminary to a general discussion on terminology. Mr. A. J. Arkell dealt with the Lower Palæolithic of the Anglo-Egyptian Sudan Mr. A. J. Wayland with the Stone Age in Bechuanaland, Mr. Neville Jones with the Stone Age in Southern Rhodesia, Mr. Desmond Clark with the chronology of the Stone Age in Somaliland and Northern Rhodesia, Dr. Ruhlmann with Moroccan Palæolithic cultures, Prof. C. Van Riet Lowe with the development of the Great Hand Axe culture in South Africa, Dr. B. D. Malan with the Middle Stone Age culture in South Africa, and Dr. Leakey with the Tumbian culture of East Africa. One morning's session was also devoted to a series of papers on rock paintings.

In the section on human palæontology the papers included an important survey by Dr. L. H. Wells on the human remains of the Middle Stone Age in South Africa, but interest was mainly focused on the fossi Australopithecine apes from South Africa and the Miocene apes from Kenya. Prof. Le Gros Clark (who immediately before the Congress had been able to visit South Africa in order to examine the important Australopithecine material in the Transvaal Museum at Pretoria and the University of the Witwatersrand at Johannesburg) gave an account of the results of his studies. The main points of this communication were as follows. There is no evidence that the Australopithecinæ bear any close relationship to the African anthropoid apes of to-day, other than that which is implied by the fact that they are both hominoids[*] of comparable size. The suggestion that the Australopithecinæ are to be regarded as anthropoid apes which, in certain anatomical features, had undergone a parallel or convergent evolution leading to a secondary but independent development of certain human resemblances must almost certainly be ruled out, for the morphological similarities to the Hominidæ in the skull, dentition, and limbs seem far too numerous, detailed and intimate to permit of such an interpretation. These similarities include the pattern, proportions and disposition of the teeth, the detailed construction of the supraorbital region, zygomatic bone, temporo-mandibular articulation and auditory region, the position and size of the foramen magnum, the contours of the maxilla and mandible, and the details of certain small foramina in the skull. Other remarkable points are the degree of wear of the milk molars in *Australopithecus*, and the fact that in the type *Plesianthropus* skull the sagittal and coronal sutures were still completely patent although the third permanent molars had fully erupted and already showed signs of wear. These points seem to indicate quite clearly a prolongation of the growth period in the Australopithecinæ comparable to that of man. The fragments of the limb skeleton which have so far been discovered present surprising features, for the lower end of the humerus and upper end of the ulna ascribed to *Paranthropus*, and the lower end of the femur and the capitate bone ascribed to *Plesianthropus*, would by themselves have been unhesitatingly ascribed to *Homo sapiens* (though a detailed metrical analysis might reveal slight differences in comparison with modern races of man). On the other hand, the talus (astragalus) of *Paranthropus* provides evidence of a degree of mobility of the front part of the foot considerably exceeding that found in *Homo*. The femoral fragment ascribed to *Plesianthropus* clearly indicates a completely erect posture and gait, probably associated with a rather wide pelvis.

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[*] The term 'hominoid' is here used in reference to Simpson's superfamily Hominoidea, which includes man and the anthropoid apes (see his recently published "Classification of Mammals").

The combination of limb bones so human in their anatomical details with a brain development scarcely exceeding that of the gorilla or chimpanzee (so far as this can be determined from endocranial casts) must inevitably raise the question whether the limb bones are correctly to be associated with the fossil remains of the skulls. But the circumstances in which they were found, together with the similar degree of fossilization, and Dr. Broom's affirmation of the complete absence of any signs of human occupation from the deposits at Sterkfontein and Kromdraai, as well as the complete absence of any remains of skulls or teeth of *Homo*, seem to leave no doubt about the correctness of the association. If this is really the case (and any possible doubts that may remain are likely to be settled soon by excavations now in progress), the conclusions to be drawn are of the greatest significance for the study of human evolution. It must be inferred, for example, that in the evolutionary sequence, limbs approximating to a human type had already been acquired at a time when the brain was still of simian proportions. At this phase of development also, the dentition had a definitely human appearance rather than that characteristic of the recent anthropoid apes. The Australopithecine material, indeed, supports the inferences drawn from the indirect evidence of comparative anatomy that many of the diagnostic characters of the recent large anthropoid apes, such as the powerful canines and the large incisors (accompanied by the 'simian shelf' in the mandible), the exaggerated development of the supra-orbital torus, the construction of the powerful brachiating arms, and certain features of the hind-limbs, are to be regarded as aberrant specializations peculiar to these apes and not as primitive features to be sought for in human ancestry. Finally, the morphological evidence of the South African fossils makes it tolerably certain that the point of divergence of the human line of evolutionary development from the line leading to the modern large anthropoid apes must be assigned to a geological date considerably earlier than many palæontologists have hitherto been prepared to accept.

In the course of his report, Prof. Le Gros Clark paid a tribute to the pioneer work of Prof. Raymond Dart of the University of the Witwatersrand, who, in 1925, was the virtual discoverer of the type specimen of the Australopithecinæ, and to Dr. R. Broom, who was responsible for the further discoveries, the results of which have been published in his recent monograph (see *Nature*, June 29, 1946, p. 863). There appeared no room for doubt that Dart and Broom had certainly not over-estimated the significance of the Australopithecinæ, and that their interpretations of these fossil remains were entirely correct in all essential details. However, the allocation of the Australopithecine fossils to an early Pleistocene, or even to a late Pliocene, date would mean that they could not themselves represent the ancestral stock from which the Hominidæ were derived. But they were almost certainly to be regarded as late, and only slightly modified, survivals of that ancestral stock.

The remains of Miocene Hominoidea in Kenya (particularly at Rusinga and Songhor) are interestingly complementary to the South African fossils, for while the latter have a specific reference to the evolution of the human line of development, the Kenya material provides important evidence for the evolution of the Hominoidea as a whole, that is, the zoological group of which the human line represents but one offshoot. Dr. Leakey's discovery of further remains of *Proconsul*, including an almost complete mandible, makes it clear that this extinct form (in spite of some remarkably primitive characters) was closely allied to the Dryopithecine apes. Far more interesting, though perhaps less spectacular, are his discoveries of the teeth and jaws of *Xenopithecus* and *Limnopithecus*. The former helps to bridge the morphological hiatus which has hitherto separated the large from the small anthropid apes, and the latter serves to link up the Kenya assemblage of Miocene hominoids with *Propliopithecus* from the Oligocene of Egypt. Much of this important fossil material has already been described and discussed in an important memoir by Dr. D. G. MacInnes.

A point of great importance which has emerged from the Pan-African Congress is that the deposits in South Africa yielding the Australopithecine material and those in Kenya yielding Miocene hominoids are exceedingly rich in fossil remains, and that systematic excavation in both these regions is practically certain, in a relatively short time, to provide the evidence required to reconstruct much that is still obscure in man's evolutionary history. It was announced at the Congress that an expedition has been organised from the University of California with the purpose of excavating far more thoroughly than hitherto the Sterkfontein and Kromdraai sites in South Africa. A complementary expedition to the Miocene deposits of Kenya in co-operation with Dr. Leakey, financed from Great Britain, was very seriously urged by the British delegates.

The Pan-African Congress on Prehistory included several excursions of great archæological interest. One excursion (lasting two days) was made to the Great Rift Valley as far north as Nakuru. Delegates were taken to the top of the Kinangop plateau, 2,000 ft. above the present level of Lake Naivasha, and were able to pick out for themselves from lacustrine deposits on the plateau obsidian points and scrapers of late Middle Pleistocene date. They also visited the obsidian mines (about forty miles distant on the other side of the Great Rift Valley) from which early man obtained his raw material. At the Kariandusi River site (near Lake Elmenteita) they inspected what was evidently a factory of hand-axes of the Acheulean type, and a visit was made to Gamble's cave, on the Mau escarpment, where remains of Aurignacian man had been found. On January 19 an excursion was made to the Acheulean site at Olorgesailie, discovered by Mrs. Leakey in 1942. Here the delegates were astonished to see hundreds of hand-axes and cleavers strewn over the eroded slopes of Pleistocene lacustrine deposits. Trenches had been cut which showed that several camp sites had here succeeded each other on a series of ancient land surfaces (interbedded between lake clays). In these deposits were found large numbers of implements, groups of 'bolas' stones, and remains of the giant baboon (*Simopithecus*), giant pig, and other extinct mammals. The whole of this site has been fenced off and partly roofed over to provide a local field museum. On the occasion of this excursion, the museum was formally opened to the public by Sir Gilbert Rennie, Chief Secretary of Kenya. Finally, at the end of the Congress, a seven-day tour was made to Arusha, Ngorongoro and the Olduvai Gorge.

It has already been mentioned that the Pan-African Congress on Prehistory was a success. It was, in fact, an outstanding success in several ways. Apart from the value of the actual scientific meetings and the interchange of ideas between prehistorians from different parts of Africa and elsewhere, the discussions led to some very important agreements with regard to terminology and also with regard to plans for co-ordinated research in the future. Finally, it was decided to set up a permanent organisation and to hold a Pan-African Congress on Prehistory every four years. At the invitation of Field-Marshal Smuts, the next Congress is to be held in South Africa in 1951.

At the final meeting of the Congress, votes of thanks were passed to the Governor of Kenya and the Kenya Government for their sponsorship of the Congress, to the people of Nairobi who had given hospitality to the delegates, and to the organising secretary, Dr. Leakey—as the result of whose enthusiasm and energy the idea of the Congress had been initiated and so successfully carried out

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PALÆOLITHIC HUMAN REMAINS IN ASIA

THE discovery of the skeleton of a child, reported to be a representative of the "Neanderthal" type, in a deposit in the Teshik-Tash Cave, near Bokhara, in Southern Uzbekistan, is a matter of considerable interest to anthropologists. The age of the individual is said to have been about eight or nine years, and the discovery was made in the course of systematic excavation by archæologists. They refer to the deposit as "middle palæolithic", and this would presumably include a Mousterian subdivision. The discovery is particularly interesting, since if confirmed it will extend very considerably eastwards the area of geographical distribution of the Neanderthal type.

Apart from discussion of the immediate surroundings and their antiquity, the characters of the skeleton are in themselves noteworthy. Dr. Weidenreich, of the American Museum of Natural History, has conferred a great benefit on students who are unable to consult the original version of the description (in Russian), by means of his critical account in the *American Journal of Physical Anthropology* (N.S. 3, No. 2, June 1945). The net result is a plea for re-examination of the skeleton, and if that be granted, the facts submitted by Dr. Weidenreich will necessarily claim further attention.

Actually Dr. Weidenreich states that he "is not convinced that the Uzbek skull is an immature Neanderthal skull belonging to the European variation", nor, he adds, "of the Mousterian European type"; and he sets out the data on which th
opinion is based.

At this point it should be noted that the child
skull is said to have been "smashed into more tha
150 fragments", from which it has been reco
structed. Moreover, the Russian observers are n
quite unanimous in their opinions, though examinati
of the original documents in Russian might reduce an
seeming discrepancy. But in consideration of t
information available, it is to be noted that D
Weidenreich cites a brief report in *Science*[1] b
the late Dr. Aleš Hrdlička on the discovery of t
skeleton in 1938 by Prof. Okladnikoff. In th
report Dr. Hrdlička is said to state that the sku
was identified by the discoverers as a "Neanderth
child". Finally, Hrdlička had the opportunity
examining the skull and concluding that some fi
or six important characters which he cited "a
denote unequivocally a Neanderthal specimen".

In the following year the Uzbekistan Section
the Academy of Sciences of the U.S.S.R. devoted a
entire fascicle to the Uzbek skull (1940). The *VOK*
Bulletin No. 9/10 for 1945 contains a report o
"Recent Work on Soviet Anthropology" by Prof.
Bunak. In this, Prof. Bunak refers to a compr
hensive monograph "now in press", which ma
represent an extension of the fascicle of 1940 me
tioned above. However that may be, Prof. Buna
reports that he has taken part in the investigatio
having been engaged in examining the brain-cas
In his opinion, the skull is "Neanderthaloid", but h
adds that while "this conclusion is beyond doub
from the modern point of view it is insufficient'
and "the extreme youth of the relic renders it difficul
to draw a definite conclusion". He concludes that i
provides valuable material for "the investigation
the variations of the 'Neanderthaloid' type".

In advocating a revision of the rather dogmati
opinion expressed by the late Dr. Hrdlička, D
Weidenreich is not unreasonable. His most effectiv
criticism relates to the form of section of the mandibl
at the chin. He notes the large 'capacity' assigned t
the skull, but on this ground he is less convincin
Reconstruction from so many fragments may b
partly responsible, and the same factor may affec
a detail to which Dr. Weidenreich might hav
pointed effectively. This is the more forwardl
directed plane of the foramen magnum as exhibite
in the tracing of the skull in the sagittal plane.

The main object of this communication is to direc
attention to the discussion and to indicate th
interest of the specimen to which it is related. D
Weidenreich's plea for re-examination is also com
mended.

In the memoir published in the *American Journa*
of Physical Anthropology (cited above), Dr. Weiden
reich renews his support (1928) of the claims mad
on behalf of the Podkumok skull (Caucasus) fo
recognition as showing a transition from the Neande
thal type to that of the modern *Homo sapiens*, an
expresses regret at the rejection by Sir Arthur Keit
of those claims. In this connexion, reference may b
made to *Nature* of October 15, 1938, p. 694, wher
there is an account of the Podkumok skull, and o
Sir A. Keith's opinion. The whole article, whic
deals, however, with European Russia, demand
reference in this place, more particularly in con
nexion with Prof. Bunak's report in *VOKS* (1945)

W. L. H. DUCKWORTH

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[1] *Science*, 90, 996 (1939).

NATIONAL CHEMICAL LABORATORY OF INDIA

By Dr. BASHIR AHMAD
Assistant Director of Planning, National Chemical Laboratory

IN pursuance of the recognition of the need for the organisation of scientific and technical research on an extensive scale for the larger objective of economic and industrial development of the country, it has been proposed to establish a National Chemical Laboratory in India. A tentative scheme for the Laboratory was drawn up in 1943 and circulated to a large number of scientific organisations and ndividuals in India and abroad. A final plan has now been formulated after a careful consideration of the suggestions received, the lines along which similar laboratories in other countries have been established, and taking into consideration also the special needs of India. This plan, therefore, incorporates the views and recommendations of a large number of leading men of science and scientific organisations all over the world.

Functions

The Laboratory will be devoted to problems of both fundamental and applied research in different ields of chemistry, and will also concern itself with developing the means for the application of scientific knowledge to practical problems of industry. The Laboratory will bridge the gulf between science and ts application to industry and will provide a link between the universities, the State and other scientific nstitutes on one hand, and industry on the other. The fundamental work undertaken by the Laboratory will be devoted to extending the frontiers of knowedge in directions likely to prove useful to the ndustrial progress of the country. The applied and developmental work will take the form of improving old processes in the light of newer scientific knowedge, and discovering new processes. This work will be carried to the pilot-plant scale in the Laboratory, after which it will be passed on to industry. The Laboratory will maintain close and continual contact with industry, the difficulties and problems of which may be referred to the Laboratory for solution. In this manner the link between the National Chemical Laboratory and industry will be vital and effective, and so will be its link with the universities and other scientific institutes in the country.

Some of the most important scientific discoveries during the last half a century, which have been of the greatest benefit to mankind, have resulted from arge organisations both of workers and of materials, and have involved expenditure beyond the means of an average research laboratory. The National Chemical Laboratory hopes to be in a position to undertake such important and expensive research.

Keeping in view the fact that problems of industry, or in the wider perspective, those of human welfare, require the co-operation of experts in different fields of science, the scope of the National Chemical Laboratory has been kept sufficiently wide. The Laboratory will include not only chemistry, but also physics, mineralogy, engineering and biology in so far as they relate to chemical problems and the chemical utilization of the national resources. The Laboratory will also provide a place for the training of research workers in specialized fields of chemistry and technology, particularly with reference to those for which there is no provision available in the existing scientific laboratories of India.

The scientific work of the National Chemical Laboratory will be divided into seven main divisions: (1) Inorganic Chemistry, including Analytical Chemistry; (2) Physical Chemistry, including Electrochemistry; (3) Chemistry of High Polymers; (4) Organic Chemistry; (5) Biochemistry, including Biological Evaluation; (6) Chemical Engineering; (7) Survey and Intelligence. In addition to these, two more Divisions are contemplated, one for Fermentation Technology, and another for Cellulose and Related Products.

Location and Staff

Poona, which enjoys a moderate climate all the year round, and is within easy reach of Bombay and its industries, has been selected for the location of the Laboratory. A site of about 470 acres on the Pashan Road on a beautiful, breezy and healthy plateau, in close proximity to educational institutions of the city, has been selected for the Laboratory.

The staff requirements of the Laboratory have been carefully considered. They are summarized below:

1. Scientific staff:	
(*a*) Director, Assistant Directors, Senior Scientific Officers, Junior Scientific Officers	51
(*b*) Research Assistants	64
2. Administration staff	42
3. Technical staff for workshop and various services	35
4. Stores, Laboratory Assistants and Attendants	86
5. Other staff	42
Total ..	320

Buildings and Finances

The floor-space requirements of buildings to house the different activities of the Laboratory have also been carefully worked out. These are as follows:

1. Main building, housing various divisions	150,000 sq. ft.
2. Ten auxiliary buildings ..	30,000 ,,
Total ..	180,000 ,,

The establishment of the Laboratory will involve a capital expenditure of 3·5 million rupees and an annual budget of 1·16 million rupees when the Laboratory is working at full strength.

NATIONAL METALLURGICAL LABORATORY OF INDIA

By Dr. G. P. CONTRACTOR
Assistant Director of Planning, National Metallurgical Laboratory

THAT India possesses great natural advantages for the production of iron and steel there is no doubt. She has rich and vast deposits of iron ore, exceeding both in quality and quantity the ores found in many States of Europe and America. These ores are reckoned to be more than sufficient for the requirements of India herself for nearly a thousand years. In spite of this, India's yearly production of steel ingots and castings in 1939 was only one million tons. The United States are producing $\frac{1}{2}$ ton of steel per man, the United Kingdom about $\frac{1}{3}$ and Japan $\frac{1}{5}$ ton per man. In India, if the target is kept as low as $\frac{1}{50}$ ton per man, she will have to produce about eight million tons of steel a year. This comparison indicates beyond a shadow of doubt that India's iron and steel industry is in an extremely backward state. Only the systematic and thorough development of the iron and steel industry, which is a basic and key industry as well as a defence industry, can facilitate the transition of India from the agricultural to the industrial stage by stimulating the growth of a number of associate or allied industries.

In order to ensure the progress and expansion of India's metallurgical industries, it was decided by the Council of Scientific and Industrial Research in 1942 that a National Metallurgical Laboratory should be established in India. Accordingly, a Laboratory Planning Committee, under the chairmanship of Sir J. J. Ghandy, director of the Tata Industries, Ltd., was constituted to formulate a scheme. A tentative scheme was prepared and circulated to technical experts, industrialists, and others in 1945. This scheme was later altered on the basis of the suggestions and comments received, and principally on the basis of the funds available. The final scheme recently prepared was approved on September 17, 1946, by the governing body of the Council of Scientific and Industrial Research.

Location

The Laboratory will be situated at Jamshedpur, which is the centre of the modern metallurgical industries in India. The Tata Industries, Ltd., have generously placed at the disposal of the Council a very suitable site for the construction of the Laboratory. Services, such as electricity, water, gas, sewage and effluent disposals are available close to the site.

Functions

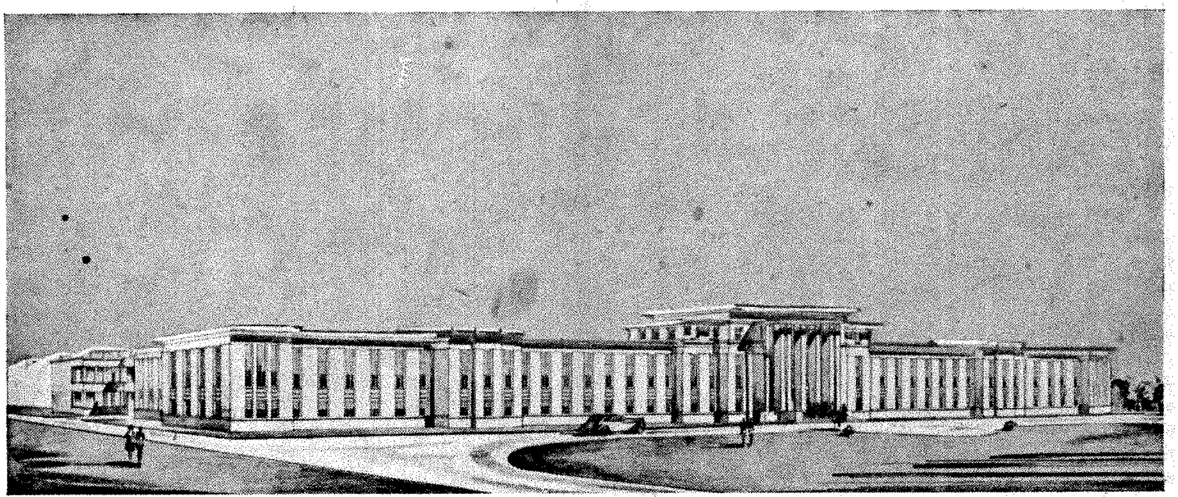
The Laboratory when completed will cover all aspects of metallurgical research, both fundamental and applied, and will carry out research on ores, minerals and refractories as applied to metallurgy. The preparation of minerals and ores and the smelting of the latter are so definitely a part of the development of the country's metallurgical industries that facilities for minerals research have been provided at the Laboratory, complete with pilot-plant equipment for semi-commercial development.

As the metallurgical industry is one of the biggest consumers of refractories, research on this subject has also been included with that on metallurgy; work on metallurgical furnace design will also be undertaken. Work on refractories will be greatly facilitated by the presence of the ore-dressing and minerals research section, with its specialized laboratory and pilot-plant assemblies.

Plans

Provision has been made in the final plans of the National Metallurgical Laboratory for administration, including statistics, library, museum, lecture theatre, etc.; chemical analysis; physical chemistry; physics as it affects metallurgical problems; the examination, preparation and smelting of metallic ores; the melting, heat treatment and working of metals and alloys; research into the structure and physical properties of metals and alloys; the electrodeposition and surface treatment of metals; and research on refractories. Facilities will be provided for the application of research results to commercial operating conditions, and for the study of such conditions as they affect the quality of the products, and the efficiency and economy of commercial production. The National Metallurgical Laboratory will work in close collaboration with the other Laboratories of the Council, particularly on long-term research of a fundamental nature.

The Laboratory is meant to function as an up-to-date research centre where knowledge of the fundamental sciences of physics, physical and inorganic chemistry, metallography, engineering, etc., will be utilized to solve the problems which confront the ferrous and non-ferrous metal industries to-day, and are expected to confront them even more in future, when competition from foreign countries will have to be met. The Laboratory is also meant to function as a clearing-house for information. It will give facilities for the training of a number of students in the application of scientific methods to the metallurgical industries, so as to enable them to take charge of technological duties in the works. To help and encourage industrialists in the solution of



ARCHITECT'S DRAWING OF THE NATIONAL METALLURGICAL LABORATORY, INDIA their problems, facilities will be provided at the Laboratory through a system of industrial fellowships.

Buildings

The Laboratory when completed will consist of a main building containing administrative offices, research laboratories, museum, lecture theatre, etc., and a separate technological block comprising large workshop-type laboratories with associated control rooms for practical semi-commercial scale operations. The main building will have three floors, the height of each floor being about 12 ft. clear underside of slab. Efficiency and convenience of operation coupled with the required degree of flexibility and adaptation to future needs were borne in mind in designing the Laboratory. The sizes of rooms were carefully planned with regard to the requirements for benches and aisles, especially for the chemical laboratories, and for natural illumination. Chemical laboratories and other rooms on the north were planned to be 32 ft. wide, this being considered the maximum depth which could be illuminated from windows on the outside wall and from the clerestory above the fume hoods on the corridor wall.

The location of the laboratories for different types of work has been carefully considered. Fume-producing laboratories have been kept to the east of the main building, while the physical and metallurgical sections, housing complicated and delicate instruments, have been placed to the west. The laboratories have been arranged, however, so as not to interfere with the convenience of working. The position of individual laboratories has also been given considerable thought. For example, laboratories where heavy objects are tested, such as the macro-room and radiography laboratory, have been placed on the ground floor. Similarly, X-ray laboratories have been planned to be located in the corner of the main building, with a lighting area on one side. The location of the museum and the lecture theatre is such that direct access can be had through the entrance without disturbing the work being carried on in the other parts of the building. The administrative section is centrally located on the second floor. In this section, facilities for statistical investigation, not only for compiling metallurgical trade figures but also for the use of statistics as a research tool in investigations on practical production and operational problems, will be provided. The library has been planned to run through two floors, with adequate provision for book-stacks and working space for book-binding, copying, etc., on the ground floor. The actual working floor area on the first floor is approximately 26,000 sq. ft., with an equivalent space on the ground floor, and about 8,600 sq. ft. on the second floor. The laboratories and the administrative section in the main building will be air-conditioned by a refrigeration system.

The technological block, providing a working floor area of about 28,000 sq. ft., has been situated to the south of the main building and, connected to it by corridors in the form of covered ways. The block consists of four main workshops or bays which are situated two on each side of the electrical power distribution station, which is in the centre. This arrangement permits the installation of generators, controls, etc., for a furnace bay on the left, and motors, etc., for a mechanical treatment bay on the right. Furthermore, this arrangement ensures the central power distribution station against dirt, dust, fumes, etc. The north end of the technological block is occupied by a mezzanine floor forming upper and lower suites of rooms for offices of the operating staff, for inspection and control laboratories, for drawing offices and for specialized apparatus in connexion with pilot-plant work.

Staff and Finance

The initial basic staff of the Laboratory is summarized as follows :

1. Scientific staff :	
(*a*) Director, Assistant Directors and Research Officers	27
(*b*) Research Assistants	26
2. Technical staff (mechanics, etc.)	25
3. Laboratory assistants	24
4. Administration	18
5. Laboratory 'Bearers'	33
Total	153

The total cost of construction and equipment of the Laboratory is estimated at Rs. 4,280,000 (£325,000). Buildings, services, air-conditioning, heavy electric plant, etc., are estimated to cost Rs. 25,00,000 (£190,000), and for equipment, provision has been made for Rs. 17,80,000 (£135,000). The recurring expenses in the initial stages are estimated at Rs. 6,00,000 (£45,000).

The foundation stone of the National Metallurgical Laboratory was laid by the Hon. Mr. C. Rajagopalachari, Minister for Education and Arts in the Interim National Government, on November 21, 1946.

CRITERIA OF HYBRIDITY

By Dr. H. G. BAKER

Department of Botany, University of Leeds

THE importance of the study of natural hybridization is obvious in view of the large part it plays in the process of evolution. There have been considerable differences of opinion, first as to the possibility of recognizing natural hybrids and, secondly, as to the status of the parents once the possibility of hybridization has been established. We are not concerned here with the second controversy, for it must be recognized, now, that the existence of hybrids both within and between species is well substantiated. Although hybrids are one of the banes of the taxonomist, their frequent occurrence in Nature makes it important that they should be recognizable without doubt. Further, when such recognition is possible they cease to be a bane.

Decline of Experiment

In 1895, Kerner[1] performed a very useful service by exposing many of the spurious criteria upheld by some of the unscientific horticulturists of his day, and he performed many crosses for himself in support of his belief that hybridization was the basis of the origin of new species. Although his pioneer technique led him to draw several conclusions which we know, to-day, to be generally incorrect, such as the true-breeding nature of hybrids (pp. 580–1), he was insistent that while some of the characters of hybrids were derived from one parent and some from the other parent, other characters were intermediate and others, again, were 'new' characters which could not be attributed to inheritance from those parents. His lists of characters of the last type are interesting. The basis of Kerner's conclusions was the experimental production of hybrids and observation of the resulting characters of the hybrids. Subsequent workers[2,3,4,5,6] have laid less and less emphasis upon this approach to the problem and have drawn up lists of criteria which may be applied to natural hybrids without the necessity of making crosses. This outlook appears to have attained such a hold that in one case where a supporter of natural hybridization[7], himself, doubted whether certain naturally occurring plants were hybrids, he did not investigate the matter by making a cross but by collecting the seed from plants of the putative parents and hybrids growing together in Nature and sowing them. There was no means of knowing which were the pollen-parents of the seedlings raised.

Huskins[8] has emphasized "that there is no one satisfactory criterion of 'hybridity' in the commonly accepted sense of the term, and that arguments based upon any one of the supposed criteria . . . must lack general validity". Even Allan[6], an enthusiastic field-observer, after repeating Cockayne's[3] criteria, is forced to admit (p. 595) "that all these may fail him, and that repeated studies are necessary for definite conclusions"; and, further, he warns that Nilsson's synthetic studies[9,10,11] on *Salix* "show the need for great caution in interpreting field-evidence".

In the United States, the index method of scoring hybrids in natural populations was introduced by Anderson[12] in 1936, and has been used by subsequent workers. Here, selected characters are assigned an index value according to their resemblances to those obtaining in the two parents, and each naturally occurring plant is scored. Very high and very low scores typify the pure species, while hybrids are intermediate. In the majority of the cases known to me where this method has been employed[12,13,14,15,16,17], its use has not been preceded by an artificial cross between the putative parent-species, differences between those species being all that were known before the natural populations were investigated. The work of Goodwin[18] with *Solidago* is an exception. There is a suspicion of a circular argument in following the assumption that certain characters are those of hybrids by their use to prove the hybrid nature of the plants bearing them. Any character which shows a number of intermediate conditions is weighted to the extent of the number of intermediates which the observer happens to be capable of distinguishing. Particularly alarming, in view of the absence of experiment, is the statement[12] "when, for instance, certain of the categories (characters) are *thought* to be more or less reliable than the others they can be appropriately weighted in combining the index". (The italics are mine.)

It is easy to overcome the faults in these methods by making it a rule that, wherever possible, artificial crosses between the forms involved (giving evidence of the mode of inheritance of the characters) should *precede* investigations of natural populations. Determined in this way, natural hybridization can never be denied. Only in the case of trees and other plants where a long period must elapse between crossing and observing the results should it be necessary to relax this rule and, even here, it is probable that the *possibility* of hybridization may be determined by observing whether the production of viable seeds follows crossing. In addition, cytological investigations may give indications of relationship.

Selection and Use of Suitable Characters

Even after the performance of such crosses, all the characters involved will not be of equal value. For taxonomic purposes, Wernham[19] divided characters into two primary categories, the 'fortuitous' and the 'biological', respectively. He defined 'fortuitous' characters as those which have "no relation to the environment nor to any biological function". 'Biological' characters were "such as are in direct relation to some vital function or advantage". Diels[20] disapproved of this terminology and substituted 'constitutive' and 'non-constitutive' for 'fortuitous' and 'biological', respectively. Then, he subdivided 'non-constitutive' characters into 'functional', 'epharmonic' and 'adaptive' characters. 'Functional' characters are connected intimately with some special function but are uninfluenced by external conditions. 'Epharmonic' characters, while being connected, apparently, with the mode of life of the plant, remain constant under varying external conditions. 'Adaptive' characters vary according to the external conditions. Sprague[21] suggested that 'plastic' would be a better term for Diel's last sub-category, and this suggestion will be adopted here.

An ideal distinguishing character must fulfil several conditions. To begin with it should be unaffected or, less preferably, affected to a known extent by the environment. A character which is affected may be of use when comparing two plants growing alongside or in exactly comparable conditions, but is unlikely to be of general use for natural populations. Obviously, the character should not vary during the course of the season in which comparative measurements are made.

The breeding behaviour of the character needs to be known. It is insufficient to know the typical condition in the two parents. The condition in the F_1 must not be a mere expression of hybrid vigour; it must be recoverable from the F_2 generation. It will be of much greater use if it is cumulatively determined by several genes, so that gradations are measurable. A simple dominant-recessive relationship is of more limited use. The occurrence of matrocliny, whatever its cause, is a possible hindrance and must be allowed for when it is known to occur. Theoretically, it might be possible for all the characters of one form to be dominant over the corresponding characters of the other, so that only in the F_2 generation would recombinations be visible. It is doubtful if this will ever be found in the case of fully differentiated species, however. Wilmott[22] suspected this to have occurred in possible spontaneous hybrids between *Geranium robertianum* L. and *G. purpureum* Vill. which occurred in his garden. However, he did not actually see the F_1 generation, so there is no proof of this.

Preferably, the ideal character should be 'constitutive' in the sense of Diels, or at least neutral so far as the ecological distinction between the forms is concerned. If it is 'non-constitutive' the action of natural selection will tend to cover up the hybridization. The character should not be closely linked with any that is 'non-constitutive', for in this case, again, natural selection will exert a covering action.

The mutation-rates of the genes controlling the character must be low. The character should be uniform over the whole distribution area of the forms so far as pure populations are concerned. Probably this is the hardest of all the conditions with which to determine agreement. Herbarium specimens and published descriptions must be consulted in most cases, and the judgment of the individual is called for in assessing the degree of agreement with the condition. An investigation of this nature is very necessary for a 'constitutive' character for, not being subject to natural selection, it may show great variability within a species. However, it must be remembered that by excessive variation such a character would cease to be 'constitutive'.

The character must be capable of easy and accurate measurement, the gradations of a colour, for example, being inferior to those of a character which can be measured with a ruler. The value of a character which can be treated more nearly objectively is that other investigators can use it with comparable results, that results obtained at different times can be compared and that an average value for a population is expressed more easily. It is a great advantage if this facility and accuracy of measurement are applicable to preserved as well as fresh material. Such material may be pickled or dried and mounted, and the changes which may occur during these processes must be taken into account. Again, the character should be measurable without removing the material from the mount or damaging it in any way.

After the most suitable characters have been selected, if it is desired to construct and use an index in the study of a population, it is preferable that characters unlikely to be affected by natural selection (that is, 'constitutive' characters) should be kept separate from those with positive or negative selection-value. Whereas the former will indicate truly the *extent* of hybridization, the latter, considered in conjunction, will indicate the severity of natural selection.

An examination of two interbreeding species (*Melandrium dioicum* Coss. and Germ. and *M. album* Garcke) has been made already[23,24], using characters selected in this way, and the method is being applied to species of *Geranium*, *Armeria* and *Arum*.

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OBITUARIES

Prof. H. P. Lewis

HERBERT PRICE LEWIS, professor of geology in the University College of Wales, Aberystwyth, died suddenly at his home at Borth, Cardiganshire, on January 22 in his fifty-second year. He was a son of the late Mr. and Mrs. Francis Lewis of Llangollen, and was a pupil of Llangollen County School, going thence to University College, Bangor. He served in the War of 1914–18 and was severely wounded. Proceeding to Downing College, Cambridge, he took the course in natural science, studying geology under the late Prof. J. E. Marr. He was for a short time a master at Oundle School, and in 1921 went to the University of Sheffield where, as a lecturer in geology, he was closely associated with Prof. W. G. Fearnsides. In 1922 he was awarded the Daniel Pidgeon Fund by the Geological Society of London, and in 1931 the J. B. Tyrrell Fund. As holder of the latter he spent some months in Canada studying the fossil faunas of the Devonian and Carboniferous rocks. In the same year he was appointed to the professorship at Aberystwyth. He was awarded an Sc.D. of the University of Cambridge in 1940; and he served on the council of the Geological Society during 1942–44.

Prof. Lewis was an all-round geologist. He was an untiring enthusiast in the field, and organised and led some of the longer field-meetings of the Geologists' Association, and attended several of their excursions to different parts of the European Continent. In spite of a permanent disability caused by his war service, he was remarkably skilful in preparing material for the microscope and in all branches of laboratory technique. He had an exceptionally wide knowledge of geological literature, and he was always most ready with expert guidance to others, whether colleague, student or occasional inquirer.

These various interests are reflected in Prof. Lewis's published papers, which include works on petrology, stratigraphy and structural geology; but it was as a palæontologist that he carried out his more extensive and detailed researches, specializing on fossil corals and the more difficult and obscure groups such as the calcareous Algæ, various kinds of micro-fossils and the problematical *Bolopora undosa*. He had for some years been mapping the geology of the Aran mountains in Merionethshire, but very little of this work has been published. Both in his research and in his teaching, his careful attention to accuracy and detail was a marked characteristic.

Prof. Lewis took an active part in the academic and administrative life of the College and the University of Wales, and held a responsible position in one of the churches at Aberystwyth. He was a man with the highest standards of duty and conduct, and his untimely death will be deeply felt. His wife, with two sons and one daughter, survive him.

JOHN CHALLINOR

WE regret to announce the following deaths:

Dr. David Hooper, formerly of the Wellcome Historical Medical Museum, on January 31, aged eighty-eight.

Dr. H. M. Tory, formerly president of the National Research Council of Canada, aged eighty-three.

NEWS and VIEWS

Advisory Council on Scientific Policy

THE Lord President of the Council, Mr. Herbert Morrison, has appointed the following to serve on the Advisory Council on Scientific Policy which has been set up to advise him in the exercise of his responsibility for the formulation and execution of Government scientific policy: Sir Henry Tizard (chairman); Sir Edward Appleton, secretary, Department of Scientific and Industrial Research; Sir Alan Barlow, Treasury; Sir Howard Florey, professor of pathology, University of Oxford; Sir John Fryer, secretary, Agricultural Research Council; Sir Claude Gibb, managing director, C. A. Parsons and Co., Newcastle-upon-Tyne; Sir Edward Mellanby, secretary, Medical Research Council; Sir Edward Salisbury, director, Royal Botanic Gardens, Kew, and secretary, Royal Society; Sir Ewart Smith, Imperial Chemical Industries, Ltd.; Sir Reginald Stradling, chief scientific adviser, Ministry of Works; Prof. A. R. Todd, professor of organic chemistry, University of Cambridge; Dr. A. E. Trueman, deputy chairman, University Grants Committee; Prof. S. Zuckerman, professor of anatomy, University of Birmingham. The Council will be served by a small scientific secretariat in liaison with the secretariat of the Defence Research Policy Committee.

Owing to Government restrictions on printing, publication of this issue of *Nature* may be delayed. Future issues will be dated as usual and published as quickly as possible after the restrictions have been removed

Australian Aboriginal Art

THE Australian aborigine, like most of the world's primitive peoples, is increasingly affected by the influence known to anthropologists as 'culture-contact'. The spread of industrial civilization brings many problems of adjustment with it, whether in the form of the 'loss of nerve' which precedes final extinction, or of that dilemma of all distinguishable minorities—the choice (whether taken by themselves or by others for them) between retention of their own special values and way of life, to the enrichment of human culture, and the easier way of assimilation into the civilization and economy of the majority. The exhibition of aboriginal cave paintings arranged by the News and Information Bureau at Australia House, London, and opened by the High Commissioner on January 15, does great credit to the Commonwealth Government at a time when there has been some anxious questioning of the probable effects upon native life of the proposed establishment of a rocket-testing range to traverse the Central Aboriginal Reserve (see *Nature*, December 28, p. 939), though there is every reason to hope that adequate safeguards are to be provided.

The exhibition is devoted mainly to an impressive series of large-scale reproductions painted in the Kimberley district during 1938–39 by members of a German anthropological expedition organised by the Frobenius Institute at Frankfort (by courtesy of the director of which the reproductions became available for exhibition): they represent a remarkable feat of recording, although the main work of describing and studying the originals over many years had been carried out, with great distinction, by Australian anthropologists. Many of the pictures show high artistic merit and a power to stir even European emotions: they have still a deep social and religious significance in the lives of the less 'Europeanized' aborigines (by whom they are regularly repainted) and are closely bound up with their mythology and dream-experience. Equally interesting is a small series of reproductions of rock paintings of a quite different character, probably dating from more ancient times; there is a striking similarity of feeling and form between these and some of the ancient paintings found, among other places, in Spanish caves and in various parts of South and East Africa, with their elongated and distorted human figures. This exhibition, which will remain open for some time, in itself refutes any suggestion that the Commonwealth Government is indifferent to the life and fate of this lowly but not ignoble people: and it can scarcely fail also to communicate to the viewer some of that fragile spirituality, so hard to crystallize in scientific terms, which is characteristic of the pure aboriginal culture and explains the disquiet felt by some anthropologists at any new encroachment of civilization upon them.

Chemistry at the University of Sydney

THE Senate of the University of Sydney has recently appointed Drs. T. Iredale, F. Lions and D. P. Mellor to three newly created readerships in chemistry. They are all well known in Britain, both by direct contact and through their work; and occupy prominent places in the scientific life of Australia. Dr. Iredale has been, for several years, the Australian local representative of the Chemical Society; Dr. F. Lions is president this year of the Royal Society of New South Wales, in which Dr. D. P. Mellor has also held various offices, being, since 1943, honorary editor of its journal, and in 1941, president.

Dr. Iredale obtained his first degree at the University of Sydney in 1918. In 1921, with an 1851 Exhibition, he began three years work on physicochemical aspects of surface tension and adsorption at University College, London, in Prof. F. G. Donnan's Department. After periods as a research officer in the Department of Scientific and Industrial Research, and as lecturer in chemistry at Armstrong College (now King's College), University of Durham, he returned to the University of Sydney. His research activities have lain chiefly in the fields of colloids, photochemistry and chemical kinetics. In 1921, he demonstrated that adsorption is the controlling factor in the inhibitive effect of protective colloids on the catalytic decomposition of hydrogen peroxide by colloidal platinum. Later, in 1923, he commenced a series of investigations of adsorption from varying vapour phases on liquid-gas interfaces. More recently, he has concerned himself with the kinetics and photodecompositions of alkyl and alkylene iodides, acetone, acetaldehyde, etc.

Dr. Lions is also a graduate of the University of Sydney. In 1923, he proceeded, as an 1851 Exhibitioner, to work with Sir Robert Robinson at Manchester, and later, in 1925, with Prof. W. H. Perkin at Oxford. In 1926 he was appointed lecturer in chemistry at Sydney. His researches have been extensive within the field of organic chemistry, particularly among nitrogen-containing heterocyclic compounds, natural products and the alkaloids. The examination of gmelinol (a crystalline substance from the 'Colonial beech') is a valuable approach to the fundamental understanding of timber faults. In addition, he has made useful contributions to stereochemistry of the diphenyl type, and in his studies of co-ordination compounds, containing copper, zinc, nickel and cobalt from nicotinylacetone, he has provided an ingenious extension of the now classical work of Mills and Gotts.

Dr. Mellor obtained his first degree and later his D.Sc. at the University of Tasmania. After periods with the Electrolytic Zinc Co. and the Commonwealth Solar Observatory, he was appointed in 1929 to the staff of the Chemistry Department, University of Sydney. He has conducted extensive investigations on complex inorganic compounds, notably those of palladium, rhodium, platinum and iridium, utilizing optical, X-ray diffraction, magnetochemical and polarographic methods. His results have greatly extended our knowledge of the stereochemistry of square complexes. During 1937–39 he worked at the Californian Institute of Technology and later at the Cavendish Laboratory, Cambridge.

Challenger Society and Staffs of Marine Laboratories: Joint Meetings

For a number of years before the War it was customary to hold meetings of the Challenger Society for the Promotion of Oceanography conjointly with the members of staffs of marine biological and fisheries laboratories in Great Britain. Three of these meetings were held each year, one of which was in London, the others being at marine laboratories or universities. These meetings were arranged under a scheme inaugurated by the Development Commissioners whereby members of the staffs of marine biological laboratories were encouraged to attend meetings at which general discussions could be held on problems of interest to them and to members of the Challenger Society. Two such meetings have been held since the end of the War, one at the Marine Biological Station at Millport under the chairmanship of Mr. Richard Elmhirst, and the other in London in the offices of the Zoological Society under the chairmanship of Dr. Edward Hindle. These meetings were well attended, and a variety of papers were given on different subjects. At Millport, papers were read under the three headings of seaweed research, plankton and productivity, and anti-fouling research. In London, contributions were made on the subjects of locomotion in marine animals and factors affecting productivity in the sea. A few papers were also given on other subjects, and arrangements were made by the secretary of the Zoological Society for a visit to the Aquarium. These joint meetings are of great value to those interested in the study of all problems connected with life in the sea, and biologists owe much to the generosity of the Development Commissioners for making them possible. It is to be hoped that such meetings will again be held regularly.

Palæontographical Society

The Palæontographical Society was founded on March 23, 1847, and the hundredth anniversary will be celebrated on March 31. The hundredth annual general meeting will be held in the conference room at the Geological Survey and Museum, South Kensington, London, at 11.0 a.m., when a commemorative address will be delivered by the president, Prof. H. L. Hawkins. In the afternoon, a public lecture on "The Story of Fossils" will be given at 2.30 p.m. by Mr. C. P. Chatwin (chief palæontologist to H.M. Geological Survey) in the demonstration room. An exhibition dealing with various aspects of palæontology will be arranged for members, and tea will be served in the Reserve and Study Gallery. Members will dine that evening in the hall of the Worshipful Company of Tallowchandlers, Dowgate Hill, E.C.4. Those wishing to attend should notify the secretary, Dr. C. J. Stubblefield, Geological Survey and Museum, Exhibition Road, London, S.W.7, not later than March 1.

Brevity in Zoological Nomenclature

Prof. J. C. Faure, of the University of Pretoria, has published a paper entitled "A Plea for Brevity—and Sanity—in Zoological Nomenclature" (*J. Ent. Soc. S. Africa*, 9, 39; 1946). He discusses the length and unwieldiness of generic and specific names with special reference to the work of Dybowski (*Bull. internat. Acad., Cracovie* (B), 1926), wherein various new generic names for Gammarids are published. In Prof. Faure's view, such cumbrous and unpronounceable products as *Gammaracanthuskytodermogammarus* (31 letters) should never have been published. He goes on to add that apparently some authors coin long names thinking that the glory devolving upon the proposer varies in direct proportion to the ponderosity of the name. Others may choose long names in the attempt to find truly descriptive names. The habit of adding prefixes or suffixes to existing names also tends to produce long and cumbersome names. Short and easily pronounceable names formed by an arbitrary combination of letters are preferable to long and cumbersome descriptive names derived from the purest classical sources.

Prof. Faure recommends that international congresses should consider whether the time has not arrived to insert into the "Rules" a provision limiting the length of names. He suggests that "No generic, subgeneric, specific or subspecific name proposed as new after ......(= a given date) shall have any status of validity or availability under the Rules if it consists of more than *fifteen* letters". But even without any such provision in the "Rules", he thinks that editors of scientific journals could exert a wholesome influence by not accepting for publication any new names that exceed a 'reasonable' length of, say, fifteen letters or that are objectionable for other reasons such as unpronounceability.

High-speed Camera

K. M. Baird (*Can. J. Res.*, 24, 41; 1946) has described, in outline, an ultra high-speed motion-picture camera, embodying new principles, which, it is expected, will enable pictures of good resolving power and illumination to be taken at rates as high as 200,000 per second. A set of lenses, mounted in a row, forms a set of images which are projected by a lens system on to rotating reflecting prisms, one prism for each lens in the row, and thence to the film which is wound in a single layer on a drum. A rotating sector placed in front of the set of lenses acts as a shutter. The sector has equidistant radial slots, so spaced that after a given slot has just passed the last lens in the row, the next slot comes opposite the first lens. Thus, the camera takes several pictures while the film moves the distance of only one, with corresponding advantage over the conventional type of camera. Intense illumination is required, but this need be of only very short duration, since any event requiring a high-speed camera naturally lasts only a very short time. To test the practicability of the design of the proposed camera, an experimental model was constructed, in which the lens system and rotating prisms were not included. In spite of these omissions, quite good pictures were obtained at rates of 70,000 a second, and a series of pictures, taken at the rate of 64,000 per second, of a rifle bullet fired at and piercing an electric light bulb, is included in the paper, illustrating very clearly the capabilities of the camera.

South African Museum: Report for 1945

The Trustees' report of the South African Museum, Pretoria, stresses the unsatisfactory financial position of the Museum, and it is pointed out that this greatly handicaps the development of its educational and cultural services. An interesting analysis of attendance figures appears in the acting director's report. This shows that during the year, 118,103 white, 56,402 coloured, and 10,499 native adult members of the population visited the Museum. The same report makes note of a special exhibit illustrating soil erosion, and pleads for similar educational propaganda in other African museums. The report of the Department of Fishes and Marine Invertebrates records the catching in South African waters (for the first time) of an adult deal-fish (*Trachypterus*) 7½ ft. in length. In the Department of Botany, Mr. G. J. Lewis carried out work in connexion with plants and allergic diseases in the Cape Peninsula. He also published illustrated descriptions of two new species of Iridaceæ (*J. S. Afr. Bot.*, **11**, 108 and 117).

Lady Tata Memorial Trust

The Trustees of the Lady Tata Memorial Fund invite applications for grants and scholarships, open to workers of any nationality, for research in diseases of the blood, with special reference to leukæmia, in the academic year beginning on October 1, 1947. Grants of variable amount are made for research expenses or to provide scientific assistants to senior workers. Scholarships are awarded as personal remuneration; their normal value has been £400 a year for whole-time research. Applications must be submitted, before March 31, to the secretary of the Scientific Advisory Committee, c/o Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1

Conference on Industrial Research

The Federation of British Industries is arranging a series of regional conferences on industry and research, the first of which will be held at Birmingham on March 25. The principal speakers will be Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research; Sir William Larke, chairman of the Industrial Research Committee of the Federation of British Industries; and Sir Peter Bennett, chairman of the Midland Regional Council of the Federation. The general subject to be discussed will be the application of science by industry, and the part research can play in promoting industrial efficiency, exports, and a higher standard of living, with special reference to industrial problems in the Birmingham area. Special attention will also be given to the smaller manufacturing concern. Further information may be obtained from the F.B.I. Industrial Research Secretariat, 21 Tothill St., S.W.1.

Announcements

The Linnean Medal for 1947 of the Linnean Socie of London has been awarded to Prof. Maurice Caulle of the University of Paris. The actual presentati of the medal will take place on May 24.

The London, Midland and Scottish Railw announces that Mr. G. E. Wilson, chemist, Scienti Research Department, Glasgow, has been appoint chemist, Scientific Research Department, Crewe, succession to the late Mr. W. Darcy. Mr. E. A. Morr senior assistant chemist, Scientific Research Depar ment, Glasgow, will succeed Mr. G. E. Wilson Glasgow.

The following appointments have been made in t Colonial Services: J. L. Congdon, to be agricultur officer, Aden; C. A. Lister, to be plant pathologis Gold Coast; W. E. M. Logan (assistant conservat of forests, Gold Coast), to be assistant conservator forests, Kenya.

Dr. C. C. Addison, lecturer in inorganic chemist at University College, Nottingham, has been award the degree of D.Sc. of the University of Durham for thesis on "A Study of Soluble Films at Liquid Surfaces

Appointments to not more than four Imperi Chemical Industries Fellowships in the University Cambridge will be made in the Easter Term, wi tenure from October 1, 1947. The Fellowships ha been established for original research in physic chemistry, biochemistry, engineering, metallurg pharmacology, chemotherapy, or in a subject relate to one of these subjects. Persons of either sex may elected, and the annual stipend of a fellow wi normally be £600. Applications must reach th Registrary, at the University Registry, Cambridg by April 20.

The Worshipful Company of Founders of the Cit of London awards fellowships, usually one a year, t provide facilities for advanced education to men wh have already completed a course of training university standard in chemistry, physics, metallurg (more especially in connexion with molten meta and allied sciences. There is no limitation to th nature of the course which may be selected; it migh include research, a period in works or foreign e perience. The normal value of the fellowship is £3 a year, and it will be renewable for a second yea and in special cases for a third year. Candidate should not be less than twenty-one years of age o September 1 of the year of application. Application must be received not later than May 1 by the Cler of the Worshipful Company of Founders, Founder Hall, 13 St. Swithin's Lane, E.C.4, to whom a inquiries should be addressed.

Messrs. Elliott Brothers (London), Ltd., 7 Victoria Street, London, S.W.1, have transferre their research laboratory from Century Work Lewisham, to Elstree Road, Borehamwood, Hert where they have a modern building of 50,000 sq. ft floor area. A new organisation is being built u which will undertake the development of industria and laboratory instruments and specialized equipment; also it will develop new techniques for th control of manufacturing processes. The laboratorie are in the charge of Mr. J. F. Coales, formerly of th Admiralty Signal Establishment, where he wa engaged on research into radio direction finding an later on the development of radar for gunnery purposes in H.M. ships.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Example of Meson Production in Lead

WE have recently obtained a clear example of meson production in lead in an experiment in which counter-controlled, cloud-chamber photographs of penetrating showers were taken in a magnetic field of 3,400 gauss. There was a layer of lead 6·8 cm. in thickness above the chamber, and the counter arrangement was such that at least two particles in the shower had to penetrate 20 cm. of lead below the chamber. The chamber was filled to a pressure of 1·5 atmospheres with a mixture consisting of 80 per cent argon and 20 per cent oxygen.

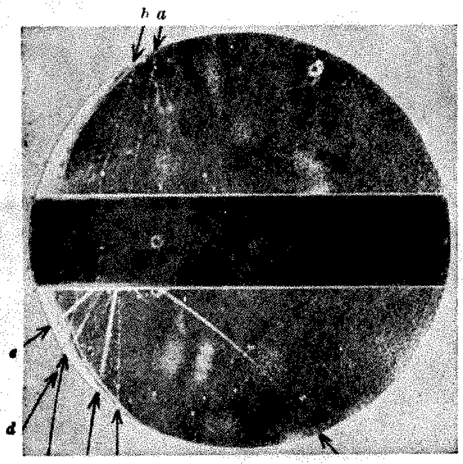

Fig. 1

The shower is shown in Fig. 1. Two fast particles *a* and *b* enter a lead plate of thickness 30·5 mm., covered above and below with brass reflecting plates each 1·8 mm. in thickness, and at least six particles, *b′*, *c*, *d*, *e*, *f* and *g*, emerge from the plate. The particles, *c*, *d*, *e*, *f* and *g*, all appear to come from a point 0·9 cm. above the bottom of the lead plate. Measurements of the curvatures of the tracks and the probable identification of the particles are given in the table. Three other particles which seem to be connected with the shower emerge from the plate, but such short lengths of track are observable that identification is not possible. The values of the momenta of the particles *a* and *b* are somewhat uncertain because of gas distortion above the plate. Only slight distortion is observable below the plate.

Particle *a*, which presumably initiates the shower, is classified as a proton or a meson, because an electron of this momentum would ionize twice the minimum and would have a high probability of producing a cascade shower in the plate. Particle *bb′* is identified as a meson or a proton. It is scattered 5° in the plate.

Of the other particles, both *c* and *e* have momenta $\sim 10^8$ eV./c. and are clearly heavily ionizing. These are presumably protons, for protons of momentum 10^8 eV./c. would ionize twenty times minimum and would have ranges of approximately 100 cm. in the chamber.

Particle *d* is positive and has a momentum of $2 \cdot 4 \times 10^7$ eV./c. Its light ionization shows that it cannot be a meson or a proton. A meson of this momentum would ionize ten times minimum, and a proton approximately two hundred times minimum. It must therefore be a positive electron.

Particle *g* is the most interesting particle in the shower, for it is undoubtedly a slow meson. Its ionization is estimated at between four and ten times minimum, and its range in the chamber is greater than 8 cm. Its momentum has been found to be $2 \cdot 2 \times 10^7$ eV./c. from measurements on two stereoscopic photographs. A meson of mass 200 m_e (where m_e is the mass of the electron) with this momentum would have a range in the chamber of 30 cm. and an ionization 10·5 times minimum. It is therefore probable that this particle is a meson. However, since the velocity of the particle is low ($\beta \sim 0 \cdot 2$), it is important to examine how much of the observed curvature could have been due to multiple scattering in the gas. Williams[1] has given an expression for the spurious curvature to be expected in such a case, and inserting the data of the experiment in his expression it is found that the radius of curvature of the track due to scattering is 123 cm. Thus the error due to scattering should be of the order of 17 per cent. The data are thus still consistent with the particle being a slow meson. A proton of this momentum would ionize 150 times minimum and would have a range of less than 0·5 cm. in the chamber.

Confirmation of the identification of particle *g* as a negative meson is given by a knock-on electron which appears on the track at a point immediately below the lead plate (see Fig. 2). (We are indebted to Dr. J. G. Wilson for helpful advice on this point.) The

Track	Ionization (× minimum)	Momentum (300 $H\rho$ eV./c.)	Remarks	Identification
a	1	$\gg 10^8$		meson or proton
bb′	1	$\gg 10^8$	Particle scattered 5° in plate. Momentum from scattering = $3 \cdot 8 \times 10^8$ eV./c.	meson or proton
c	>10	$\gg 10^8$	Observed length of track in chamber = 2·2 cm.	proton
d	1	$2 \cdot 4 \times 10^7 \pm 20\%$	Positive particle: radius of curvature 23·3 cm. error does not include error due to scattering. Ionization slightly greater than minimum. Observed length of track in chamber = 3·2 cm.	electron
e	>10	$\gg 10^8$	Observable length of track in chamber = 3·6 cm.	proton
f	1		Has curvature of negative particle, but kink in track makes momentum measurement uncertain	meson or proton
g	7	$2 \cdot 2 \times 10^7 \pm 25\%$	Negative particle. Radius of curvature 21·2 cm. Error includes error due to scattering. Curvature uniform along length. Range in chamber >8 cm.	meson

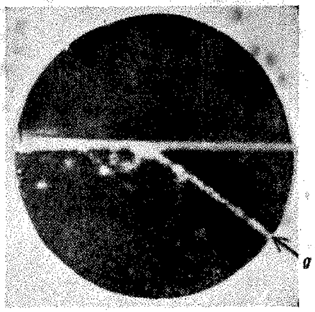

Fig. 2

momentum of this electron is $1 \cdot 51 \times 10^5$ eV./c. and its kinetic energy is $2 \cdot 3 \times 10^4$ eV. Assuming a 'head-on' collision and a particle of mass 200 m_e, the energy of the electron would be $4 \cdot 8 \times 10^4$ eV. The corresponding figure for a proton would be 570 eV. Moreover, the actual kinetic energy of the knock-on electron may be greater than the observed value because it is not certain that the electron has been knocked on in the gas. If it be assumed that the electron has been knocked on in the gas, the mass of the particle g is found to be 290 $m_e \pm 50$ per cent. In the statement of the error account has been taken of the errors of measurement and the scattering of particle g and the knock-on electron in the gas.

The shower seems, therefore, to be a clear example of the production of at least one meson (of mass 200 m_e), one electron and two protons at a point in a lead plate.

The total kinetic energy lost by the particles a, c, d, e, f and g in the lead plate is of the order of 2×10^8 eV.

Unambiguous photographs showing the production of mesons in a cloud chamber are exceedingly rare. Anderson and Neddermeyer[2] obtained in 1936 a striking photograph of a disintegration in a lead plate which showed a heavily ionizing particle projected upwards. They were unable to identify the particle with any particle then known. It may well have been a meson. Powell[3] and Hazen and Fretter[4] have inferred the presence of mesons in disintegrations by range and ionization density measurements.

The present photograph seems to conform in general type to the process of meson production proposed by Hamilton, Heitler and Peng[5], with the addition suggested by Jánossy[6]. Interpreting the shower according to this theory, particle a would be a proton which has already produced a meson (bb') and which produces another meson, an electron, and recoil protons. On this theory the electron results from the decay of an extremely short-lived meson. The life-time of 10^{-8} sec. used by Hamilton, Heitler and Peng is, however, much too long: a life-time of the order of 10^{-11} sec. is required.

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Jan. 17.

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[3] Powell, W. E., *Phys. Rev.*, **69**, 385 (1946).

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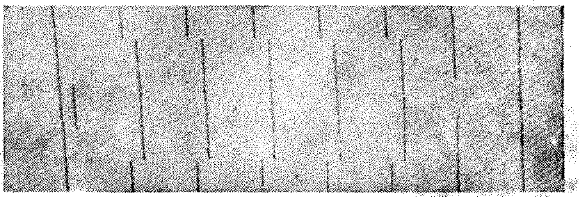
Interferometric Determination of Apparent Thickness of Coatings

THE thickness of deposit from an atomic beam is measured as follows. The film (X) is deposited on a high-grade flat through a grid-like mask of thin metal held in close contact. Then the mask is removed from the flat, and a highly reflective opaque coating (Y) is evaporated over the whole. The steps on the surface of the flat, which are the edges of X, appear in the surface of Y. A second flat with a highly reflective but slightly transparent coating (Z) is then brought close up, and the interferometer thus formed is examined by the reflected system of multiple beam precision fringes of equal thickness[1]. The accompanying reproduction, which was taken in a parallel beam of green light from a filtered mercury arc, shows the appearance of the fringes with a thickness of $X = 569$ A.



POSITIVE PRINT OF REFLECTED SYSTEM OF FRINGES OF EQUAL THICKNESS

During reflectivity experiments with evaporated metal films a similar technique was adopted for determining the apparent thickness, except that the interferometer was examined with white light and a spectrograph to obtain channelled spectra[1]. This does not require so perfect a pair of optical flats and removes any ambiguity from the determination due to integral order fringe displacements. In such a system the flat carrying film Z must be optically isotropic to eliminate spurious polarized fringes.

By adopting the reflected fringe system for measurements, the following advantages over the transmitted system are secured: (i) The transmission properties of layer X become unimportant. (ii) It is possible to deposit Y to an opaque thickness and so eliminate the dependence of the phase-change at reflexion on the underlying material. (iii) Layer Y attains its maximum reflectivity when it is just opaque. (iv) Subsidiary defects tend to sharpen the fringes; for example, (a) lack of parallelism in the incident light, (b) intensity-curve distortion due to the blackening characteristic of the photographic plate. In the latter case microphotometer records show that, for the same pair of silverings, the photographic image of the reflected fringe system can be about one third the width of that of the transmitted system.

Silver was used for Y and Z in our experiments. The accuracy attained was ± 3 A.

To ensure that the thicknesses of Y deposited above X and the base are equal, it would seem desirable to bake the base *in vacuo* and then cool it during the evaporation. As high-grade optical flats cannot well be treated in this manner, the part of the base on which the measurements are to be made is first covered with a substrate of the material X. Then during the deposition of layer Y, the outgassing will be presumably uniform over the whole surface and no error in thickness should occur. Furthermore, any changes of structure in X or Y will be identical on both sides of the boundary.

The mass of metal contained on an area of film of measured thickness was determined by a colorimetric chemical method[2] capable of giving an accuracy of ± 3 per cent. From this the apparent density of the film of silver was derived. Typical results are:

Thickness (A.)	122	214	448	518	520	735
Density (gm./c.c.)	10·4	10·5	10·5	10·2	10·2	10·5

The density of solid silver is 10·5.

The reflectivities of the silver films were measured and the resulting curves compared with those of Goos[3], who used a micro-balance to estimate the mass of silver per square centimetre. The thicknesses he gives *assume* a density equal to that of solid silver in all cases. After correcting for differences in reflectivity at opacity, his curves and ours are in good agreement, also showing qualitatively that the apparent density of our silver films is 10·5.

Measurements of the electrical conductivity[4] of metal films show that the film continuity at a given thickness depends essentially on the cleanness of the surface and the degree of vacuum during evaporation. Our conditions are such that the films used for the thickness measurements probably have the fine-scale discontinuous structure revealed in electron microscope photographs[5]. This being the case, the 'thickness' of the film is a difficult quantity to define. We refer to the thickness deduced from the procedure described above as the 'apparent thickness'. Our measurements on silver show that this figure corresponds to that which would exist if the grains were smoothed to a uniform film having the density of the solid metal. It can be argued that the density of 10·5 found for these films is a necessary result if the opaque film *Y* is continuous in structure.

It may be that our conclusion does not hold if *X* and *Y* are not of the same material, and experiments on this are now being performed.

The atomic beam measurements were made by A. Khamsavi, the reflectivity by W. K. Donaldson.

Note added December 30.—Since the submission of the above account another letter has been published[6] which includes some common details. The necessity of eliminating the effects of the phase change at reflexion was early realized by us, and we thank Mr. Plessner for his acknowledgment of the information.

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Measurement of Out-of-Phase Magnetic Fields in Betatrons

Fig. 1 gives a plot (Curve *A*) of the magnetic field at the orbit (19 cm. radius) of a 20-MeV. betatron for the first thirty minutes of arc of the quarter period during which the electrons are accelerated. The peak field is 3,600 gauss, reached at 90°, corresponding to 20 MeV. Fig. 1 also shows, again for Curve *A*, the equivalent injection voltage as a function of time; for 20-kV. injection the pulse, assumed infinitely short for simplicity, should be applied to the electron gun at some 25–26 minutes of arc, that is, about 8 microsec. after the instant of zero field. The magnetic field at injection will then be about 25 gauss.

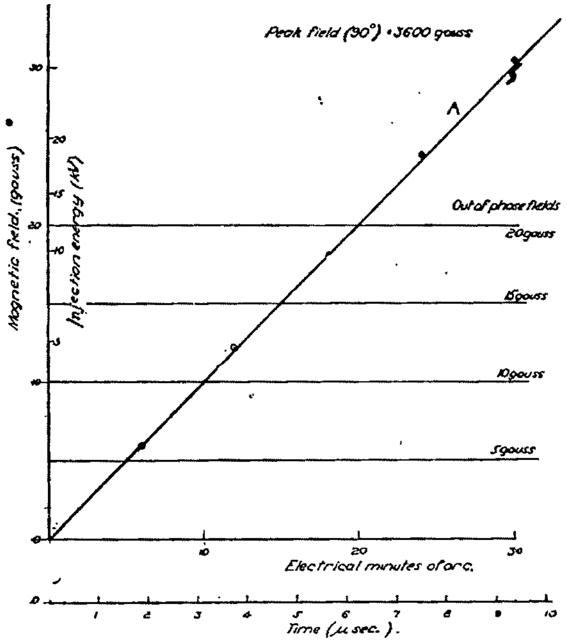

Fig. 1

Kerst[1] mentions that out-of-phase magnetic fields due to eddy currents in the magnet, etc., reduced the X-ray output in his betatron by a factor of 1·5–2, and corrected for them by passing D.C. through his expander coils. This implies that the out-of-phase fields were not serious in his case, and to a first approximation were uniform round the orbit circum-

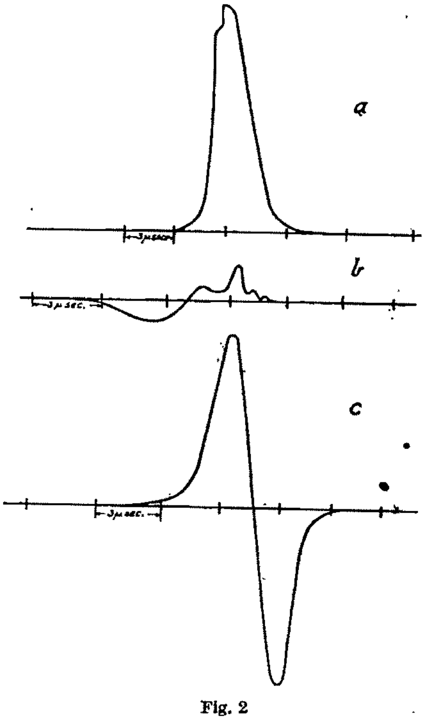

Fig. 2

ference. No data or measurements on these fields were given by Kerst in his paper.

We have recently had occasion to devise a method for detecting and measuring approximately out-of-phase fields in a betatron. Consideration of the horizontal lines of Fig. 1, which are in fact parts of sine waves (90° out of phase with the main accelerating field), representing out-of-phase fields varying from 5 to 20 gauss, explains the method. We use two peaking transformers (the cores of which are each made of five short strips of 2·5 mil 'Permalloy *C*') which provide short voltage pulses very near the point of zero field (such as those at the intersections of the horizontal lines and the inclined line in Fig. 1). If, for example, the resultant fields at two points are in phase, the two-peak pulses would cancel out, if in opposition. Examination of the resultant diagram obtained in this way on a cathode-ray oscillograph enables an estimate to be made of the local out-of-phase magnetic fields.

Typical records are shown in Fig. 2. Fig. 2*a* shows the pulse from a single-peaking transformer; Figs. 2*b* and 2*c* show the resultant pulse obtained from two similar peaking transformers in opposition showing, in the case of Fig. 2*b*, a difference in the out-of-phase fields between the two positions of the peaking transformers of less than 0·8 gauss. In Fig. 2*c* the difference in out-of-phase fields is about 6·3 gauss. We have in this way mapped the out-of-phase fields around the pole-pieces of the betatron magnet.

Since the above tests were made, an abstract of a paper has appeared[2] in which a very similar method is described in brief outline.

We acknowledge the invaluable help given by Mr. S. W. Redfearn of these laboratories, and thank Sir Arthur P. M. Fleming, director of research and education here, and Mr. B. G. Churcher, manager of the Research Department, Metropolitan-Vickers Electrical Co., Ltd., for permission to publish this note.

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[1] Kerst, D. W., *Rev. Sci. Inst.*, **13**, 287 (1942).

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Crystallization of Supersaturated Solutions by Means of Electric Current

According to a paper by Ubbelohde[1], when electrolysing supersaturated solutions of some electrolytes, for example, copper sulphate, crystallization takes place on the copper anode. Some possible causes are mentioned, as, for example, colloidal particles or ionic clusters approaching the anode and then causing crystallization.

The same phenomenon had already been observed in concentrated solutions of copper sulphate, and various explanations were put forward[2]. Only one investigator[3] mentions as the possible cause the increase of concentration taking place at the anode due to the electrolysis. The following experiments with supersaturated solutions make it probable that this indeed may be the only cause.

If, on electrolysing, the increase of concentration was prevented, no crystallization took place; on the other hand, if an increase of concentration was caused in a different way, then crystallization took place even without electrolysis. Increase of concentration at the anode was hampered in three ways:

(1) By stirring. In some cases crystallization was prevented; generally not, probably because sufficiently intensive stirring could not be realized in the supersaturated solution.

(2) By using other materials for the anode. Current-densities equal to and considerably stronger than those causing crystallization on a copper anode did not produce crystallization on platinum, carbon, tungsten or silver, but did on brass.

(3) By using alternating current. In this case an increase of concentration in the first half-period is neutralized in the second half-period. Indeed, no crystallization took place on copper electrodes with frequencies of 1–15,000 per sec., the current densities being a multiple of those that in the same time clearly caused crystallization with continuous current (3–15 mA./cm.^{2}). (It should be noted that in our experiments crystallization was not observed for current densities so small as those applied by Ubbelohde (1 mA./cm.^{2}).)

With still lower frequency (1/18 per sec.), however, crystals appeared on the anode at normal current density. It was evident that at this frequency the increase of concentration in a half-period was sufficient to form crystallization nuclei.

A calculation of the concentrations occurring at the anode is given by Nernst and Schoenfliesz[4]. With an initial concentration c_0 gm.equiv./l. and a current density of i amp./cm.^{2}, the concentration of the electrolyte after t sec. is:

$$c = c_0 + \frac{2vi}{\sqrt{\pi D}}\sqrt{t},$$

where v is quantity of $CuSO_4.5H_2O$ produced in 1 sec. by a current of 1 amp. on the electrode surface.

A supersaturated solution of copper sulphate with $c_0 = 0{\cdot}50$ gm./cm.^{3} crystallized within 10 minutes at a current density i of 0·060 amp./cm.^{2}. Extrapolation of the transference number and coefficient of diffusion to a concentration of 0·5 gm./cm.^{3} from data given by Thovert and Wille[5] gives $n_{an} = 0{\cdot}74$ and $D = 19 \times 10^{-7}$ cm.^{2}/sec. From the formula given we calculate for c after 10 minutes 1·7 gm./cm.^{3}. Now it was found that a supersaturated solution, $c = 0{\cdot}8$ gm./cm.^{3}, crystallized within 10 minutes.

It also appeared that on changing i, the time necessary for starting the crystallization to some extent satisfied the relation $i\sqrt{t} =$ constant, as was to be expected from the above equation. The quantitative observations were, however, not readily reproducible.

Finally, the following is of importance. Simple reasoning from the ionic transference shows that, when electrolysing a solution of barium hydroxide, an increase of concentration occurs at the cathode. In agreement with this, electrolysis of a supersaturated solution of barium hydroxide caused crystallization to start at the cathode.

Summary. When electrolysing supersaturated solutions of electrolytes, it is possible that by the transference of ions at one of the electrodes, such a high concentration occurs that spontaneously crystallization nuclei are formed, which then grow in the supersaturated solution.

This investigation was suggested by Prof. W. G. Burgers.

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Laboratory for Physical Chemistry,
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Delft.
Dec. 18.

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Stress-Optical Properties of Rubber

CONSIDERABLE progress in the quantitative description of the mechanical properties of rubber has taken place in recent years by the consideration of a rubber as a network of statistically kinked long-chain molecules. A treatment of the optical properties of strained rubber on this basis, assuming the links of the molecular chain to be themselves optically anisotropic, has been developed by Kuhn and Grün[1] for the special case of a simple elongation, and by me[2] for the general homogeneous strain. In the latter case, the rubber has three principal refractive indices, n_1, n_2 and n_3, corresponding to the three principal axes of the strain ellipsoid.

For light propagated along a principal axis, the birefringence is found to be

$$n_1 - n_2 = C_1 N(\lambda_1^2 - \lambda_2^2), \tag{1}$$

where N is the number of chains per c.c. of the network, and λ_1, λ_2, λ_3 are the principal extension ratios. The stresses t_1, t_2 and t_3 are related to the principal extensions by equations of the type

$$t_1 - t_2 = NkT\ (\lambda_1^2 - \lambda_2^2). \tag{2}$$

Hence the birefringence in a principal plane is proportional to the difference of the principal stresses, and to the difference of the squares of the principal extension ratios.

By stretching a rubber sheet in two perpendicular directions in such a way as to produce a homogeneous strain, it has been possible to test these theoretical predictions. The closest agreement was obtained when the rubber was swollen with a solvent. Fig. 1, which refers to a pure gum natural rubber swollen in paraffin to about twice its original volume, confirms equations (1) and (2) fairly precisely.

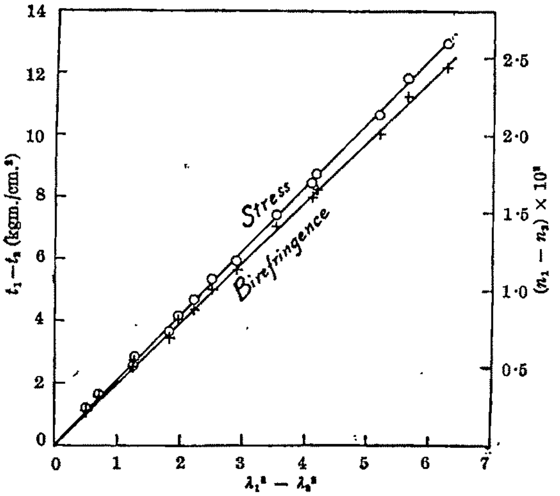

Fig. 1. DEPENDENCE OF DIFFERENCE OF PRINCIPAL STRESSES AND BIREFRINGENCE ON DIFFERENCE OF SQUARES OF PRINCIPAL EXTENSION RATIOS

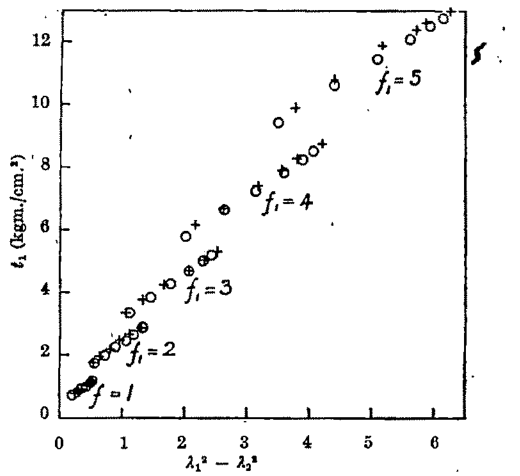

Fig. 2. CROSSES, EXPERIMENTAL RESULTS; CIRCLES, CALCULATED FROM MOONEY'S THEORY, WITH $G = 2{\cdot}0$, $K = 0{\cdot}2$

In these experiments the stress (t_3) normal to the sheet was zero. In this case, the stress t_1 in the direction corresponding to λ_1 is, according to the theory,

$$t_1 = NkT\ (\lambda_1^2 - \lambda_3^2), \tag{2a}$$

where λ_3 is the extension ratio in the direction normal to the surface of the sheet. However, on plotting t_1 against $(\lambda_1^2 - \lambda_3^2)$, the points fall, not on a straight line, but on a series of arrays (Fig. 2). In any one of these arrays one *force* f_1 (corresponding to the stress t_1) is constant, while the other force f_2 varies.

A physical explanation of this departure from the behaviour predicted by the molecular theory has not been found. It is, however, exactly the type of behaviour to be expected from the more general theory of elasticity developed by Mooney[3], on the assumption that Hooke's Law is obeyed in shear. From Mooney's theory, the principal stresses are found to be related to the extension ratios by equations of the type

$$t_1 - t_3 = (G + K\lambda_2^2)\ (\lambda_1^2 - \lambda_3^2). \tag{3}$$

With a suitable choice of the constants G and K, the graphical solution of these equations leads to results which, when plotted as in Fig. 2, agree remarkably well with the experimental data.

For the dry rubber, on the other hand, Hooke's Law was not obeyed in shear, and neither the molecular theory nor Mooney's theory accounted quantitatively for the experimental data, though Mooney's theory provided the closer approximation.

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Luminescent Decomposition of Nitrous Oxide

THE thermal dissociation of nitrous oxide has received considerable attention in the past in connexion with the collision theory of unimolecular and bimolecular reactions[1], and it is known that oxygen atoms can be produced as a result of the primary dissociation $N_2O = N_2 + O$. This dissociation was considered to be the chain-initiating process in the H_2—N_2O reaction by Melville[2], and in the CO—N_2O reaction by Bawn[3]. In view of the production of atomic oxygen in the decomposition of nitrous oxide, some work has been carried out on the N_2O—SO_2 system in order to obtain some basic information on the association reaction $SO_2 + O = SO_3$, a process believed to be of some importance in relation to the oxidation of sulphur dioxide in flames[4]. This work will be reported in detail elsewhere; but it is the purpose of this note to describe some observations on the nature of the luminescence accompanying the decomposition of nitrous oxide at temperatures of the order of 900° C., and the effect of various additions on this. Zeldovitsch and Jakovlev[5] have studied briefly the explosive decomposition of nitrous oxide at high temperatures, and the appearance of yellow-green flashes in the combustion of carbon in nitrous oxide at 600–800° C. has been recorded by Shaw[6] and Arthur[7].

A flow method was used in which nitrous oxide was passed at a steady rate through an electrically heated quartz tube, 3 cm. in diameter and 20 cm. in length, at one end of which was a quartz window. The temperature of the tube was raised at a steady rate of 10° C. a minute, and no luminescence was observed in the decomposing gas for temperatures up to 850° C., although above 750° the exit gases were tinged brown, due to the formation of oxides of nitrogen. At 850° a very pale yellow-green haze was seen in the tube, and the rate of increase of temperature was reduced to 5° C. a minute. The intensity of the glow gradually increased, and at 900° a vivid luminescence was given. At a flow-rate corresponding to a time of contact of 3 sec. a series of flashes occurred, and by adjusting the rate to correspond to a time of contact of 1 sec. it was possible to maintain a steady glow of high intensity.

When 1 per cent by volume of chlorine was added, the intensity of the glow was very much reduced, and with 2 per cent chlorine the glow disappeared. On the addition of a similar quantity of sulphur dioxide the intensity of the glow was apparently unaltered, although visual observation was complicated by the formation of a dense cloud of sulphur trioxide. Formation of the latter, detected by the formation of sulphuric acid mist on bubbling the exit gases through water and simultaneous measurement of the dew-point of the exit gases[8], in the N_2O—SO_2 system was found to take place at temperatures so low as 550–600°, where the decomposition of nitrous oxide as revealed by ordinary manometric methods is exceedingly slow.

The spectrum of the glow was recorded on a Hilger medium quartz spectroscope and was found to consist of a continuum extending from the visible to the ultra-violet with a maximum intensity in the yellow-green. With long exposures it was possible to observe faint emission bands superimposed on the continuum, and these were found to be due to nitrous oxide. In its general characteristics the glow accompanying the high-temperature dissociation of nitrous oxide is very similar to that given when nitric oxide reacts with atomic oxygen in a discharge tube, or is added to flames containing oxygen atoms; it can be attributed to the association reaction $NO + O = NO_2 + h\nu$ (continuous), a process which has been described in detail by Gaydon[9].

The formation of nitric oxide in the decomposition of nitrous oxide is usually considered to arise from the attack of atomic oxygen on it: $N_2O + O = 2NO$; although at temperatures of 900–1,000° C. the possibility of the primary dissociation $N_2O = N + NO$ also arises. Both these reactions require a high energy of activation[10], and sufficient nitric oxide; a visible glow with the atomic oxygen present is not given until high temperatures are attained.

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A Novel Method of Making Aerosols

THE phenomena occurring when a closed vessel containing a simple liquid is heated to a temperature above the critical temperature of the liquid are well known. What happens when a solution, and more especially a solution of a substance having a very small vapour pressure, is treated in the same way is perhaps less familiar, although the findings of several investigators are on record[1]. In some binary systems a partial separation of the components takes place as the critical point is approached; in others, no heterogeneity can be detected even when the liquid phase has vanished. In this connexion we have made some observations in small-scale experiments in which sealed capillary tubes (1 mm. bore, with thick walls) partly filled with aqueous solutions of potassium chromate were slowly heated. Even when the concentration of potassium chromate was increased to 50 gm. per 100 ml., no separation of solid occurred when the critical temperature (in this case, about 430° C.) was attained, and the whole of the system passed into the vapour state, the colour of the solute becoming uniformly distributed throughout the tube. On cooling, liquefaction took place and the original solution was spontaneously re-formed.

In our view, the most remarkable feature of these events was that a refractory solid had been completely vaporized at a temperature some 500° C. below its melting point, and it occurred to us that this method of bringing substances of very low volatility into the vapour state might be used for the production of aerosols of these materials, provided a rapid expansion of the vapour, accompanied by dilution with air, could be arranged (cf. the formation of smokes by condensation). We therefore repeated the experiment of heating a sealed tube containing a 50 per cent solution of potassium chromate in water, but on this occasion heating was continued until the tube burst. The explosion took place in a small room, and we were able to show that an aerosol of potassium chromate had been formed. Most of the particles in a cloud sample, obtained by means of a thermal precipitator, were of the order of 1 μ diameter, but a small number of more massive particles (about 10 μ diameter) were also found. Although this cloud compared unfavourably, as a dispersion, with the smokes that can be made by conventional methods, we are of the opinion that a more uniformly and more finely dispersed system could be obtained by more careful control of the expansion and dilution of the vapour mixture than was attempted in the test we have described.

These observations were made in 1941, and we are grateful to the Director-General of Research (Defence), Ministry of Supply, for permission to publish this account. One of us (B. A. T.) is no longer in the service of the Ministry.

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[1] For a bibliography of earlier literature, see "Solubility Measurements in the Region of the Critical Temperature", by C. H. Holder and O. Maass, *Canad. J. Res.*, **18**, Sec. B, 293 (1940).

Absolute Axes and Tidal Forces

IT has been shown[1] that at any point of space-time, whether empty or occupied by matter, it is possible to define a system of absolute axial directions, independently of the Ricci tensor, and, in general, uniquely. The method makes use of a tensor which has since been proved by Ruse[2] to be identical with the conformal curvature tensor of Weyl. It may be supposed that this system of axes is of mathematical interest only, but it appears possible to give it a simple physical interpretation.

The complete Riemann – Christoffel tensor B_{ijkl} can be expressed in terms of the Ricci tensor G_{ij}, and the conformal curvature tensor C_{ijkl} by the formula[1,2]

$$B_{ijkl} = C_{ijkl} - \tfrac{1}{2}(g_{ik}\,G_{jl} + g_{jl}\,G_{ik} - g_{il}\,G_{jk} - g_{jk}\,G_{il}) + \tfrac{1}{3}(g_{ik}\,g_{jl} - g_{il}\,g_{jk})G. \qquad (1)$$

Since G_{ij} and C_{ijkl} have each ten, and B_{ijkl} has twenty, independent components, it follows that G_{ij} and C_{ijkl} are algebraically independent.

Thus, the conformal curvature tensor represents certain properties of the field which are independent of the Ricci tensor and, therefore, of the stress-and-energy tensor derived from it. These properties must be independent of the nature and motion of the matter at the point, since the latter are fully described by the stress-and-energy tensor. They must, therefore, represent effects of the outside world on conditions at the point.

The idea, therefore, suggests itself that the conformal curvature tensor represents the tidal forces, these forces being due to external gravitating bodies and showing themselves in a distortion of the shape of a deformable body placed at the point. That this interpretation is probable may be shown by considering a weak static field, which can be represented by a Newtonian potential.

Thus, in the Schwarzschild field of an isolated particle, the components of C_{ijkl} reduce effectively to two, which may be written[1]

$$C^{23}_{23} = C^{14}_{14} = -\frac{2m}{r^3},\; C^{31}_{31} = C^{24}_{24} = C^{12}_{12} = C^{34}_{34} = \frac{m}{r^3}. \qquad (2)$$

The Newtonian potential is

$$V = \frac{m}{r}; \qquad (3)$$

and we have

$$C^{23}_{23} = -\frac{\partial^2 V}{\partial {x_1}^2},\; C^{31}_{31} = -\frac{\partial^2 V}{\partial {x_2}^2},\; C^{12}_{12} = -\frac{\partial^2 V}{\partial {x_3}^2}; \qquad (4)$$

x_1, x_2, x_3 being Cartesian co-ordinates coinciding locally with the spherical polars.

In this case, therefore, the solid harmonic of the second order which represents the disturbing potential of the tidal field is given by the quadratic form

$$C^{23}_{23}\,dx_1^2 + C^{31}_{31}\,dx_2^2 + C^{12}_{12}\,dx_3^2. \qquad (5)$$

By superposition we can generalize this form for all Newtonian fields. To obtain a tensor form we must replace the linear elements dx_1, dx_2, dx_3 by the orthogonal surface-elements dS^{23}, dS^{31}, dS^{12}. We are thus led to consider the quadratic form

$$C_{ijkl}\,dS^{ij}\,dS^{kl}, \qquad (6)$$

which is the basis of the system of absolute axes referred to[1].

In a general Newtonian field the tidal forces at any point may be explored by placing there a small, freely falling, non-rotating fluid planet. This will then, in general, take up an ellipsoidal shape, under the joint influence of its own gravitation and the external tidal forces. The directions of the principal axes of the ellipsoid depend only on the external field and may be taken as the directions of a system of absolute local Cartesian co-ordinates.

In a general Einstein field, which may be strong and rapidly changing, the appropriate generalization of this system is given by the system of local Galilean axes with directions defined by the conformal curvature tensor.

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Stabilization of Penicillin in Aqueous Solutions by Low Concentrations of Phosphates

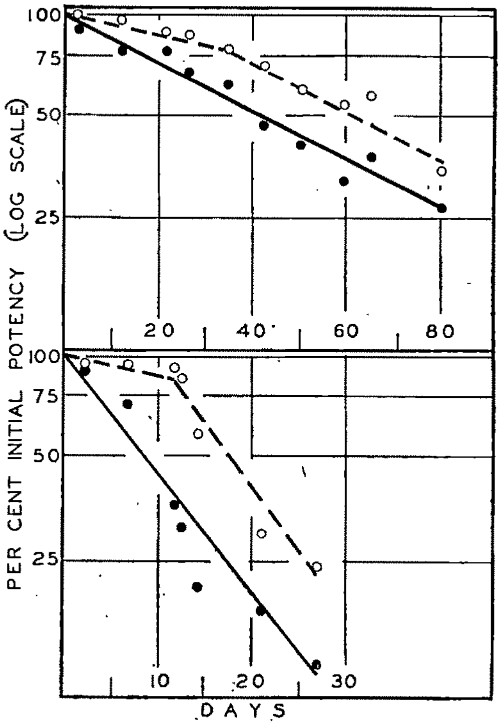
THE practical problems presented by the instability of penicillin in aqueous solution are well known, and much attention is being focused on their solution. The importance of these problems is intensified by the current trend toward commercial production of penicillins of increased purity, since it is now well recognized that, under comparable conditions of storage, sterile aqueous solutions prepared from crystalline penicillin *G* lose their antibacterial potency more rapidly than do solutions prepared from partially purified penicillin of somewhat lower purity.

Following clues suggested by the results of fermentation experiments[1], it has been observed repeatedly in these Laboratories that addition of small amounts of phosphate, in the form of suitable mixtures of monobasic and dibasic potassium or sodium phosphates, markedly retards the destruction of penicillin in aqueous solutions. Less phosphate is required to 'protect' partially purified penicillin than crude liquor. When the present work was well under way, a publication[2] appeared which tended to corroborate these observations. The presence of sodium chloride (physiological saline U.S.P.) in the solution does not interfere with the protective action of the phosphate. The effect is probably independent of, or at least is not dependent primarily upon, the buffer action of the phosphates on the hydrogen ion concentration of the solution, since the same effect has been noted in different experiments set up with initial *p*H values from 5·7 to 6·8. In none of these did the *p*H change more than 0·1 unit during the period of observation. Furthermore, the *p*H values of control solutions in saline containing no phosphate have been very close to the *p*H of the solutions containing phosphate, yet the latter have repeatedly been shown to be more stable.

Experiments have been carried out with solutions of penicillin varying in initial concentration from about 2,000 to about 20,000 units per millilitre and stored at temperatures from 2° C. to 50° C. Values outside these limits have not been studied except in the case of crude liquors. The observations have been duplicated many times during the last two and a half years using crude liquors*, solutions prepared from commercial penicillin from numerous production lots ranging in purity from 846 to 1,156 units per milligram and a preparation of crystalline penicillin *G*.

The optimum concentration of phosphate for solutions prepared from partially purified sodium or calcium penicillin is about 0·005 M. The optimum concentration-range with respect to unitage of penicillin is relatively wide for the sodium salt, being in the order of 0·0525–0·184 millimoles phosphate per 10^5 units of penicillin; but is much more critical for the calcium salt. The useful life of sterile solutions of sodium penicillin in physiological saline is increased three- to five-fold, depending upon the temperature, when phosphate is present in a concentration of five millimoles per litre and 0·0525 millimoles per 10^5 units. The three- and five-fold increases are for solutions stored at 2° C. and at room temperature (*c.* 25° C.), respectively. The useful life has been taken as the time required for loss of 15 per cent of the antibacterial potency. This figure was chosen because under the present regulations of the Food and Drug Administration 15 per cent leeway is permitted in the potency of penicillin preparations. If desired, the sodium chloride content of the saline may be reduced slightly in such solutions so that the solution is isotonic with normal saline. This seems unimportant, however, since calculations[3] show that introduction of the phosphates in the concentrations employed increases the lowering of the freezing point only 0·018° C., the equivalent of less than 0·3 gm. NaCl/l.

The phosphate may be incorporated in the saline solution to be used as a diluent for the dried penicillin or may be added to the concentrated aqueous solution of penicillin prior to lyophilization† in such quantities that, upon solution of an aliquot of the dried penicillin in a suitable volume of saline, the desired concentrations of phosphate with respect to molarity and to unitage of penicillin will be obtained. For routine work we have used 60/40 mixtures of equ molar stock solutions of monobasic and dibas phosphates. The exact concentrations that we hav used most extensively in our phosphate-saline mi tures are NaCl, 0·14 M. (8·18 gm./l.); $NaH_2PO_4.H_2O$ 0·003 M. (0·41 gm./l.); and Na_2HPO_4, 0·002 M (0·28 gm. anhydrous salt/l.). This solution, havin a calculated freezing point lowering of 0·56° C., isotonic with blood serum. The results obtained i typical experiments with a sodium salt of penicilli are shown graphically in the accompanying figure.



Per cent initial antibacterial potency remaining in sterile solutions of sodium penicillin in physiological saline U.S.P. (solid curves) and in saline containing 5 millimoles phosphate per litre (dashed curves) after different periods of storage at 2° C. (upper pair of curves) and at room temperature, that is, about 25° C. (lower pair of curves). In this set of experiments initial concentration of phosphate with respect to penicillin = 9,525 units per millilitre; initial concentration of phosphate with respect to penicillin = 0·0525 millimoles per 10^5 units; and *p*H = 6·7

It should be emphasized that, as was pointed ou above, the relative concentrations of phosphate an of penicillin are critical with calcium penicillin. Whil remarkable success has universally attended attempt to stabilize solutions of sodium penicillin with phosphates, only about half the trials with the calciu salt have been successful. The optimum concentration of phosphate for preserving calcium penicilli is probably about 0·005 M., and the optimum concentration of phosphate with respect to penicilli is probably in the vicinity of 0·15 to 0·18 millimole of phosphate per 10^5 units. Concentrations of phosphate that are satisfactory with one lot of calciu penicillin, however, may be unsatisfactory with another lot, indicating perhaps that the qualitativ and/or quantitative nature of the impurities presen is important in determining the effectiveness of th phosphate treatment for a given lot of the calciu salt. A tendency for a white precipitate (presumabl calcium phosphate) to form has been noted whe certain lots of calcium penicillin were treated wit the mixture of phosphates, whereas solutions prepare from other lots have remained clear.

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* The initial concentrations of penicillin activity in the crude liquors varied from 50 to 200 units per millilitre and the *p*H at harvest varied from 6·7 to 7·4.

† This technique may be used entirely satisfactorily with sodium penicillin, but has not been tried generally with the calcium salt.

The mechanism responsible for the protective action of phosphates on penicillin is not clear at present, but it may well be effected through an esterification of part of the molecule similar to that reported for a number of other compounds of biological interest[4], and a consequent blocking of an enzyme system involved in the processes of destruction.

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New Substances Exerting a Combined Bacteriostatic and Respiration-inhibiting Effect on Tubercle Bacilli

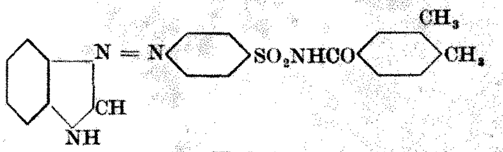
MOST of the preparations with a chemotherapeutic effect against tubercle bacilli which have hitherto been tested have been bacteriostatic. The reactions occurring between chemotherapeutic substances of this type and the bacterial cell are of a reversible character. A considerably better effect should be achieved if a preparation producing irreversible changes could be discovered. The simple sulphanilamides, that is, those the effect of which is counteracted by *para*-aminobenzoic acid, are typical of such bacteriostatic substances. They give a good effect *in vitro*, and in animal experiments they show a definite though weak effect[1]. Derivatives of the simple sulphanilamides, for example, promin, have given better results in *in vivo* experiments[2].

It seems probable that the value of the sulphanilamides as chemotherapeutic agents would be greatly increased if, in some way, they could be made to interfere with bacterial metabolism directly. Simple sulphanilamides and promin certainly can interfere in bacterial metabolism. Thus measurements of the respiration of pathogenic human tubercle bacilli in a Warburg respirometer show a reduction in oxygen consumption under the influence of sulphanilamide, sulphathiazole, sulphanilylmethylpyrimidin, promin and other substances[3]. This effect can, however, only be detected when very high concentrations, for example, 0·2–1·0 per cent of the substances are used.

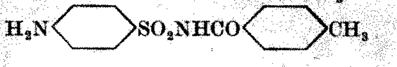
In ordinary therapeutic concentrations, the sulphadrugs have no action in inhibiting respiration even if the cultures have been treated with them for several days or weeks previous to the test with the respirometer. It is possible that the desired effect might be achieved if bacteriostatic substances were coupled with substances inhibiting respiration. These experiments have therefore been aimed at finding out whether chemical combination of two such substances would give a compound which retained its capacity for interference in bacterial metabolism. It is possible in some cases to produce compounds having such an effect, as has been shown by Dr. H. Willstaedt, Wenner-Gren's Institute, Stockholm, who very kindly placed them at my disposal[4,5].

The effect of such compounds in inhibiting the growth of tubercle bacilli on Löwenstein's medium was studied, as well as their effect on respiration, in order to find out whether they would show the same or better bacteriostatic effect than that of the components. It had been shown that with a mixture of the components the effect was merely additive.

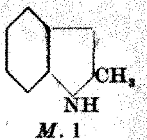
In the accompanying table are given the results of tests on [2-methyl-indole-(3-azo-4)-benzene-1-sulphonyl]-3,4-dimethylbenzamide (*W.* 134)[6], and its components *p*-amino-benzenesulphonyl-3,4-dimethylbenzamide('Irgafen') and 2-methylindole (*M.*1). Their effect was tested on pathogenic human bacilli.



W. 134



'Irgafen'



M. 1

Substance	Elementary formula	Mol. wt.	Total inhibition			Inhibition of respiration as % of that in the control	
			Dilution	gm./l.	Millimol./l.	20 mgm. %	40 mgm. %
M. 1	C_9H_9N	131	1/8,000	0·125	0·96	35	85
'Irgafen'	$C_{15}H_{16}O_3N_2S$	304	1/10,000	0·100	0·33	0	10
*W.*134	$C_{24}H_{22}O_3N_4S$	446	1/16,000	0·063	0·14	45	65

It appears from the table that inhibition of growth occurred with a concentration of 1/8,000, 1/10,000 and 1/16,000 respectively for the substances methylindole, 'Irgafen' and their combination product. The concentration in millimol./litre of the substances is 0·96, 0·33 and 0·14 respectively.

One of the substances coupled, 'Irgafen', has little or no effect on the oxygen consumption of the tubercle bacilli, but methylindole and the finished product diminish it appreciably.

It is thus possible to produce a compound which can interfere with bacterial metabolism by combining two growth-inhibiting substances, of which one is a powerful inhibitor of respiration, and by these means obtain better bacteriostatic power than with either of the substances coupled.

Experiments with many other similarly constructed compounds are in progress. Reports on these will be given later.

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Influence of *dl*-Methionine and Other Substances on the Nephrotoxic Action of *dl*-Serine

dl-SERINE introduced either by stomach tube or by intraperitoneal injection causes severe kidney damage in young rats[1,2]. In view of the probable interaction of serine and methionine in the rat[3,4], the influence of methionine on the serine effect was studied. Male rats weighing approximately 100 gm. were given 100 mgm. *dl*-serine by stomach tube and killed 24 hours later. Litter mates received the same amount of serine, and in addition *dl*-methionine in amounts varying from 100 to 600 mgm. subcutaneously in several injections preceding and following the administration of serine. 24 rats given serine alone showed extensive renal necrosis localized in the region of the cortico-medullary junction (see Fig. 1). Of 39 animals given methionine in addition, 30 showed no lesions or only minute lesions (see Fig. 2). Only in two rats was no protective effect seen.

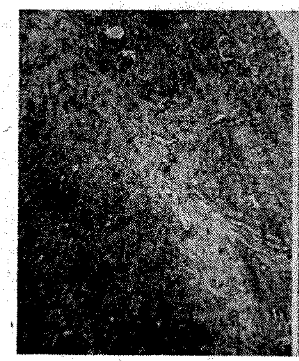

Fig. 1

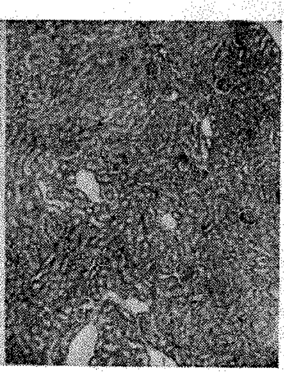

Fig. 2

Fig. 1. NECROSIS IN THE KIDNEY OF A RAT ON A PROTEIN-DEFICIENT DIET FREE FROM VITAMIN B COMPLEX SACRIFICED 24 HOURS AFTER THE ADMINISTRATION OF 100 MGM. *dl*-SERINE BY STOMACH TUBE. (× *c.* 50)

Fig. 2. COMPLETE PROTECTION AGAINST THE NEPHROTOXIC ACTION OF SERINE BY TWO INJECTIONS OF 100 MGM. *dl*-METHIONINE IS SEEN IN THE KIDNEY OF A LITTER-MATE FURNISHING FIG. 1. (× *c.* 50)

Of other sulphydryl compounds tested, *l*(+) cysteine hydrochloride was considerably less effective, while glutathione (glutaminylcysteinylglycine) regularly afforded complete protection. *l*(+) Glutamic acid had a slight influence, but glycine exerted considerable protection. Similarly *dl*-alanin, glycolic acid (hydroxyacetic acid) and *dl*-threonine prevented the nephrotoxic action of *dl*-serine. *l*(+)Histidine monohydrochloride, *l*(+) arginine monohydrochloride, lactic acid, pyruvic acid and butyric acid afforded some protection, while sodium chloride and sodium acetate were without any influence.

These experiments are being extended and will be published in detail.

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Circulation in the Frog

MOST text-books of elementary zoology contain an account of the circulation of the frog. These accounts, which are based largely on the views of Brücke[1] and Sabatier[2], differ in minor details, but agree that the frog's heart, though possessing only a single ventricle, functions, nevertheless, so that the so-called arterial blood, returning by the pulmonary veins, is mixed only slightly with the venous blood. The mixed blood is sent through the systemic arches to the hinder part of the body. Meanwhile the head region is supplied through the carotid vessels with pure arterial blood, while the greater part of the venous blood is sent through the pulmo-cutaneous vessels to the lungs and skin.

This hypothesis, based on somewhat slender experimental evidence, proved very satisfactory, no doubt, to the nineteenth-century comparative anatomists. Then it seemed natural to seriate the incomplete double circulation of the frog, as an example of the Amphibia, between the single circulation of the fish on one hand and the double circulations of certain reptiles, birds and mammals on the other. Since the time of Brücke, however, many facts have been discovered. For example, the incompletely divided heart of *Lepidosiren* has been described[3]; again, the results of palæontological investigation have shown that, so far as their skeletal elements are concerned, the modern Amphibia have departed widely from the structure exhibited by the earliest members of that group[4]. In addition, there have been described[5,6] certain abnormal hearts of individual frogs in which the circulation could not possibly take place as the Brücke – Sabatier hypothesis requires; the fact that such frogs were apparently capable of leading a normal existence shows that the supposed selective distribution of the blood is, in fact, unnecessary.

In more recent years, Ozorio de Almeida[7] and Noble[8] claim to have demonstrated by experimental methods that in certain Amphibia in which the interauricular septum is complete and a spiral valve present in the conus, the arterial and venous bloods mix but little. However, Vandervael[9], who was the first to place an illuminant under the heart and observe the passage through it of Indian ink particles by means of transmitted light, found that very considerable mixing does take place. This author also directed attention to certain physiological considerations, notably the extensive cutaneous respiration of the frog, and concluded that a mixing process is much more likely to be in keeping with the frog's mode of life; for when it is submerged the skin will be the only source of oxygen supply (apart from any stored in the lungs). He suggests that when lung breathing is used, it will supplement the oxygen content of the blood obtained from cutaneous and bucco-pharyngeal respiration, and that, by mixing, this increase will be distributed to all parts of the body.

Recently[10], Vandervael's experiments have been repeated using methods which obviate both the possibility of the injection increasing the cardiac intake in such a way as to invalidate the results, and also that of affecting the heart by heat derived from the illuminant. The results obtained confirm Vandervael's observations. By the methods used it can clearly be seen that (*a*) the spiral valve of the conus does not direct the first blood to leave the ventricle into the pulmo-cutaneous vessels, as the old hypothesis requires; (*b*) that the blood commences to move and ceases movement in the carotid, systemic and pulmo-cutaneous arches simultaneously and not consecutively; (*c*) when Indian ink particles are introduced into the blood-stream by way of the pulmonary vein, they are distributed to carotid, systemic and pulmo-cutaneous trunks and not to the first two of these only; and (*d*) when introduced through one of the anterior venæ cavæ, or a tributary of these, Indian ink is not excluded from the carotid circulation.

This work has now been extended[11] by the introduction into the blood-stream of the radio-opaque medium 'thorotrast'; its subsequent movements being traced by serial radiographs made at intervals of a few seconds. This has overcome the difficulty of making direct observations with transmitted light and has provided permanent records of the distribution of the injection medium when injected both through the pulmonary vein and vena cava routes. These radiographs give no support whatever to any non-mixing hypothesis, and indicate strongly that considerable mixing does, in fact, take place.

We are thus faced with the situation that, on the experimental evidence before us, the non-mixing hypothesis is not proved; it is also at variance with the evidence derived from the physiological study of the frog's heart and the study of abnormalities. Palæontology, so far as it can be introduced into the present argument, points strongly to the fact that it is undesirable to attempt to place the modern Amphibia anywhere near the main line of vertebrate evolution. In the present state of our knowledge, it seems best to regard the frog's heart, with its adaptations for receiving its oxygen and food supplies from the blood passing through it and not, as in other vertebrates, by way of a coronary supply, as being specially adapted to an animal in which a high proportion of the respiratory exchange is cutaneous.

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Jan. 7.

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A Mistaken Symbiont of *Oliarus cuspidatus*

Buchner[1] mentions somewhere in his work, unfortunately not available here, that in the absence of general knowledge of symbiosis, spermatozoa have been recorded in the literature when they were really bacteria. At least in one instance enthusiasm has led to a mistake in the opposite direction, for spermatozoa have been illustrated as bacteria. *Oliarus cuspidatus* is a Fulgorid insect which is supposed to contain as many as five tumours, each with a specific symbiont of its own; this record being the highest claimed so far. It is a rare insect in Germany, where even Buchner was unable to procure any specimen for his own investigation. Šulc[2] found it near Brno in Czechoslovakia, and our knowledge of symbiosis in this insect is entirely due to him.

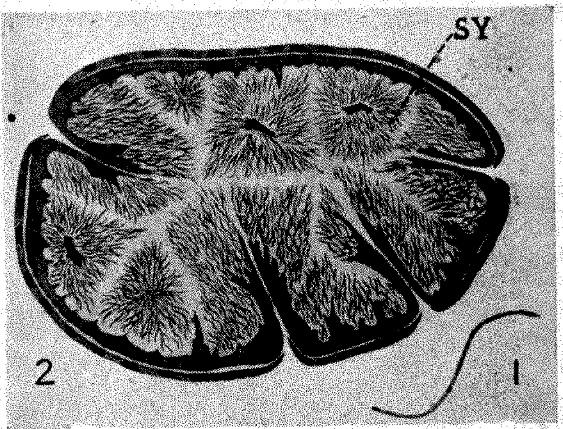

Fig. 1. Symbiotic bacterium of *O. cuspidatus* according to Šulc, who has idealized it as such. Reduced to ⅔

Fig. 2. Section of tumour with symbiotic bacteria *SY*, in *O. cuspidatus*, according to Šulc. This is a male gonad, *SY* being spermatozoa. Reduced to ⅔

I spent some four months in Brno, where Prof. Šulc kindly procured for me a few specimens of *O. cuspidatus*. In the following year I moved to Prague, where Dr. Stepanek, of the National Museum of Natural History, kindly directed me to a locality from which I obtained a few living specimens of this insect. Neither at Brno nor at Prague could I confirm the existence of bacteria illustrated by Šulc[2] in his Fig. 21, which I have copied (see Fig. 1). The micro-organism is so long that anyone searching for it should have easily confirmed the previous record. The tumour containing these long bacteria has been named by Šulc "interfollicular mycetome" and illustrated in his Fig. 20, showing the symbionts as *Sy*; his illustration has been copied (see Fig. 2). Strangely enough, I could not even find this tumour in *O. cuspidatus*. Buchner[3], and more recently H. J. Müller[4], have studied Fulgoridæ, but neither their studies nor those of Šulc himself upon other Fulgorid insects refer to an interfollicular tumour, *O. cuspidatus* being the only exception recorded in the literature.

After much labour and disappointment I have come to the conclusion that Šulc has unwittingly illustrated the testis of a male insect, and naturally mistaken the spermatozoa for bacteria. In the male gonad the spermatozoa lie relatively scattered and are radially arranged; both these features are clearly expressed in Fig. 2. On the contrary, a section of an insect tumour shows the tissue cells thickly seeded with bacteria which grow in all possible directions. Such an infected cell of the Fulgorid insect, *Fulgora europœa*, has been illustrated by Buchner[3] in his Fig. 6, Plate VIII, which is in harmony with that of another insect, *Cicadella viridis*, as illustrated also by Buchner in Fig. 18, p. 137.

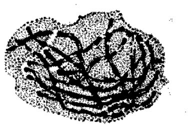

Fig. 3. Symbiotic bacteria of *Tricentrus assamensis* showing interplasmatic infection; magnification 12 × 60; camera lucida drawing

To my knowledge a bacterium in symbiosis with insects which excels all others in length and thickness, when these qualities are considered jointly, is to be found in an Indian Membracid, *Tricentrus assamensis*. A smear from this insect shows pieces of protoplasm with interplasmatic infection (Fig. 3). The bacteria never show any approach to a radial arrangement, typical of spermatozoa as seen in Fig. 2. The bacteria, on the contrary, grow in more than one direction, a feature well brought out in Buchner's illustrations mentioned above. On account of the large size of the bacteria found in *T. assamensis*, it has made possible the correct interpretation of more than one mysterious problem in the literature on symbiosis. Šulc's illustration (Fig. 2) is a genuine representation of an insect testis, only misinterpreted as a tumour; but his Fig. 1 here has been idealized as a bacterium to suit a preconceived theory. The wavy shape of the objects in Fig. 2 further suggests their being spermatozoa.

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Helminth Parasites of Limpets

During investigations of the helminth parasites of the British limpets *Patella vulgata*, *P. intermedia* and *P. depressa*[1,2] in relation to a possible bearing of parasitism on mortality and sex-proportions[3], three larval trematodes (*Cercaria patellæ* Lebour[4], an unidentified *Xiphidiocercaria* and an unidentified tailless cercaria) and one larval cestode have been found (see table).

Host species	No. of specimens examined	Number of specimens found infested with			
		C. patellæ	*Xiphidiocercaria*	Tailless cercaria*	Cestode
P. vulgata	3631	121 (3%)	7 (0·2%)	22 (4%)	4 (0·1%)
P. intermedia	595	49 (8%)	10 (1·7%)	26 (19%)	1 (0·2%)
P. depressa	1417	278 (20%)	nil	12 (5%)	nil

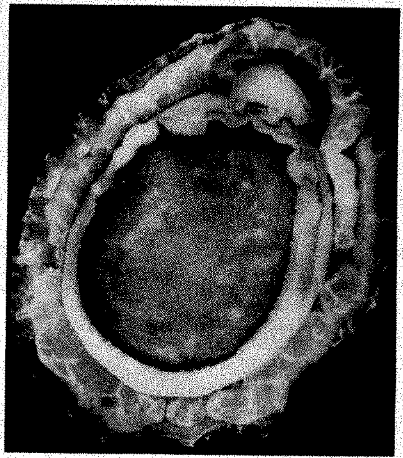
* Only 957 specimens (all species) were examined for this parasite.

C. patellæ is the commonest, is most abundant in autumn and is of special interest as a source of living cercariæ for class-work. It has been found on the west coast of Britain in several localities between Cornwall and Millport, and at Aberdeen, Cullercoats and Plymouth, being most abundant in *P. depressa* at Port St. Mary, Isle of Man, and at Trevone, north Cornwall.

Each of the three trematodes occurs independently in the digestive gland, the cestode being encysted on the surface of the visceral mass. The tailless cercaria is visible only under the microscope in smears of digestive gland tissue, but infestations of each of the other three parasites can usually be seen on lifting the foot forward from the visceral mass.

C. patellæ is commonest in *P. depressa*, but since in all three species it is more common in populations inhabiting rock pools than in those living in exposed situations, the apparent preference for *P. depressa* may be because this species occurs in pools or at low water, whereas the other species frequent 'dry' habitats.

Most limpets infested with *C. patellæ* are in the larger size (age) groups. The infestation in *P. depressa* at Port St. Mary is 10 per cent in specimens less than 35 mm. in length, increasing to 100 per cent in those more than 65 mm. (cf. Rothschild[5,6]). One of the more obvious effects of parasitism is castration of the host, infested limpets rarely having gonads normal in size; only 20 per cent, about two thirds of which were female, were found with identifiable sex products. The effects of infestation on the host organs have been discussed by Rees[7]. There is no apparent difference in vitality between infested and uninfested limpets, although in the final stages of infestation only a very small portion of the digestive gland remains unaffected. Infestation may, however, have an important effect on mortality and sex ratio in the larger individuals of all three species.


Patella depressa (Trevone) showing mantle veinlets filled with cercariæ ready for escape. (Natural size)

The sporocysts of the *Xiphidiocercaria* are restricted to a limited portion of the digestive gland or, rarely, kidney. No sporocysts of the tailless cercaria have been observed.

C. patellæ has been found to escape from the host by means of the veinlets in the mantle skirt which, filled with cercariæ, show white and opaque against the translucent mantle (Fig. 1). It is suggested that migration of cercariæ within the hæmocœle, and subsequent escape from the mantle, may be a common occurrence in other molluscs infested with larval trematodes.

The number of cercariæ given off by the limpet *in vitro* is greatest just after immersion in water. Up to 330 cercariæ may emerge in the first hour, the rate of escape then steadily falling and finally ceasing after about thirty hours immersion (compare Cort[8]). Under natural conditions there is probably a rhythm imposed by tidal fluctuations, the cercariæ only escaping when the host is covered by the tide.

The final host of *C. patellæ* is as yet unknown, although Nicoll[4] suggested that it may be a bird. It is possible that moribund or recently dead sea-birds, perhaps fouled with oil, may provide material, for which I should be grateful.

A full account of the work will be published later.

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SEA WAVES

By P. J. H. UNNA

Secondary Waves and Tidal Streams

THE following symbols are used :

D = depth
L = length of primary.
H = height of primary.
$S = H/L$ = steepness of primary.
V = speed of primary.
L', etc., relate to secondary waves on crest of primary.
L'', etc., relate to secondary waves in trough of primary.
L'_0, etc., relate to secondary waves at mid-height of primary (at orbit centre level).
a = run.
v_a = water speed at crest.
a_s, v_{as}, relate to surface water.
a_0, v_0, relate to water at bottom.
L_0, H_0, S_0, V_0, relate to deep water.
Units—pounds, feet, seconds, except where otherwise stated.

Expressions showing the changes which take place in secondary waves, according to their momentary positions on a trochoidal deep-water primary, have already been explained[1]. The general forms, which cover all values of D/L for the primary, are :

$$\begin{array}{l|l} L'/L'_0 = 1 - \pi S.\coth\dfrac{2\pi D}{L} & L''/L'_0 = 1 + \pi S.\coth\dfrac{2\pi D}{L} \\ H'/H'_0 = L'_0/L' & H''/H'_0 = L'_0/L'' \\ S'/S'_0 = (L'_0/L')^2 & S''/S'_0 = (L'_0/L'')^2 \end{array}$$

For a deep-water primary these reduce to $L'/L'_0 = 1 - \pi S$, etc., as previously given ; and for a 'long' primary, $L'/L'_0 = 1 - \frac{1}{2}H/D$, etc.

The expressions are only strictly correct when L'_0/L is small.

The general expressions may be relevant in regard to the question of the depth of water in which waves of given height will start to break[1], but that is a subject on which many other considerations arise, and so it will not be discussed now. But the forms which apply when the primary is a 'long' wave show how tidal streams can, in certain circumstances, affect the state of the sea in a way which was not noted when waves and tidal streams were previously discussed in *Nature*[2].

Effect of Tidal Streams

The tidal wave will be taken as the primary, and the principal wind-formed waves as secondaries, and so H becomes range of tide. But whether the secondaries happen to be close inshore, or in mid-channel, D must be taken as the average depth throughout the width of the channel. Similarly, with an open coast, it would have to be taken as the average depth for many miles out.

The expressions to be used are naturally those for a 'long' primary, and they will only be strictly applicable where tide and half tide prevail ; while they will not have much effect unless the sea is fairly shoal, and the range is large. But they may have considerable consequence in places, for with a range of 16 ft., and soundings averaging 25 fm., the steepness of the sea should theoretically vary by 16 per cent as between high and low water, S'/S'_0 and S''/S'_0 working out at 1·08 and 0·92.

The conditions here are different from those previously considered in *Nature*[2]. The former note on effect of tidal stream stated that "Change in direction or strength of stream will not change the steepness of the waves if they are travelling through an area of uniform tidal strength—uniform maximum strength". It was intended to infer that the same strength of stream would be encountered at any given moment throughout the area, and that any change in stream would take place simultaneously, also throughout the area ; and with that proviso the statement was perfectly correct. But a long-term view must now be taken, covering half the tidal period, so that at any given moment both stream and change in stream may differ as between one position and another. Then the waves crowd up and shorten, and the energy crowds up and makes them higher when the water crowds up on the flood, with the reverse during the ebb. The resulting theoretical difference in steepness, as between high and low water, merely depends on the geometrical properties of the elliptic trochoid (tracing curve an ellipse) appropriate to the values of L, H, D.

But the expressions must not be applied too literally, for that would imply that the tidal wave behaves as it ought to do ; whereas if it did so, full strength of stream would be given by $\frac{1}{2}H\sqrt{g/D}$, equivalent to $1{\cdot}7\ H/\sqrt{D}$ knots, which is not the case. The probability is that tidal movement is greatly affected by irregularities in coast line and soundings, and also by reflexion of the tidal wave. But nevertheless, the argument that where the water crowds up, the waves, and their energy which is carried by the water, must do the same, holds good ; and that will apply both for tide and half tide, and also in estuaries, where the stream turns at high and low water by the shore. So where an estuary has a large H/D, it may be anticipated that the sea will be heavier at high than at low water ; and perhaps this is the reason why, in an onshore wind, the water so often seems to quieten down towards low water, even before the weather-going stream has ceased to run. In this connexion the following figures are relevant :

With tide and half tide :

H/D	0·1	0·3	0·5	0·7
S'/S'_0	1·1	1·4	1·8	2·4
S''/S'_0	0·9	0·75	0·65	0·55

In the Bristol Channel

	H/D at mean springs
Lundy	0·12
Ilfracombe—Mumbles	0·25
Foreland—Porthcawl	0·35
Watchet—Barry	0·6
Flatholm	0·7

This may account for the Bristol Channel pilots' allegation, previously mentioned in *Nature*[2], that the heaviest seas off the Foreland occur at high water. At neaps, and in other estuaries with smaller range, the effect would naturally be less. In any event, the above figures can only give quite a rough idea of what should happen, for, especially in an estuary, the waves have plenty of time, during half the tidal period, to run between positions with greatly differing values of H/D, and that complicates things a lot. For example, L'_0 would differ as well as H/D.

Lastly, it is worth noting one curious consequence. Where two tidal waves interfere, the change in the state of the sea, as above explained, should be greatest where the streams are weak, and least at the nodal position, where they are strong.

Shore Breakers

The essential condition for pure breaking is that v_{as} should just exceed V. That happens in deep water when $S = 0{\cdot}13$, a far greater steepness than waves of substantial length can then attain, unless they meet a weather-going stream[3]. When they are so steep, they are distorted from trochoidal profile, the crests being further steepened into sharp-edged ridges[4]. An extra steep crest of this sort can only be piled up if v_{as} is specially increased, so the effect of distortion is to hasten breaking, and that also applies when the water is shoal—when D/L is small.

But breaking can also be hastened in extraneous ways. In deep water, for example, secondary waves become steeper when they happen to be on the crest of a primary[5]; and if they become steep enough to break, the disturbance they set up may eliminate the small margin of stability of a steep primary, and so cause the primary to break. Besides that, when they are near breaking point, their own water-speed is large, perhaps large enough to bring the combined speed due to primary and secondary up to V. But that would be a local and transitory effect, and so might fail to operate. The same considerations apply to shoal water.

Another extraneous cause of breaking is too rapid change in depth[6].

It is also possible that breaking is hastened when the waves are wind forced, for a favourable wind will increase v_{as}, while its pressure might tend to make the crest tilt forwards; and wind acting against swell should have the reverse effects. The second effect would almost certainly be small, and the first one probably so, if the waves are big enough to be of material consequence. Steep short seas scarcely matter, and can be disregarded.

Breakers by the shore may be divided into three or possibly four classes, which may merge one into the other according to circumstances:

(*a*) The clean-cut curler, entirely due to v_{as} managing to exceed V. If S_0 is large it only occurs where the beach is steep; but if S_0 is small it may also be seen where shoaling is gradual.

(*b*) A crest so steep in front that it ultimately collapses into surf[7]. That seems to occur when S_0 is small.

(*c*) Multiple lines of surf, typical of large S_0, with gradual shoaling. At the outer line, where breaking starts, the water merely begins to trickle down the wave front, and with swell that is the stage at which surf-riding becomes feasible.

(*d*) Breaking hastened by extraneous causes, such as too rapid change in depth, or secondary waves.

The expression S_0, as used here, refers to inshore deep water steepness; and so, with swell, not its steepness in the area of generation, which may be thousands of miles away[8]. It will be taken as $0{\cdot}05$, $0{\cdot}025$, $0{\cdot}01$, to represent a heavy sea, a moderate sea, and a long low swell; and its description as large or small in the above classification of breakers must be given a good bit of latitude.

The two relevant expressions affecting shore breakers are: $D/L = S_0 \times S/S_0 \div H/D$, where S/S_0 is a definitely calculable function of D/L, so long as the waves remain trochoidal[9]; and $S_0 = 1 \div \pi \left(\frac{S}{S_0} \times \coth\frac{2\pi D}{L}\right)$, the condition for v_{as} being equal to V, again only for trochoidal waves. On this basis breaking would start when $D/L = 0{\cdot}071$, $0{\cdot}052$, $0{\cdot}036$, and $H/D = 1{\cdot}87$, $1{\cdot}93$, $1{\cdot}97$, for $S_0 = 0{\cdot}05$, $0{\cdot}025$, $0{\cdot}01$. Of course, H/D can never exceed 2, for at that figure the beach in front of the breaker would be absolutely dry; and even with $H/D = 1{\cdot}87$ it would be almost dry, except for backwash, so that $1{\cdot}87$ may be taken as typical of a heavy sea curling over on to a steep beach. When D/L is as low as $0{\cdot}04$ the waves would be, to all intents and purposes, in the 'long' state.

In fact, this way of treating waves is not mathematically exact, for it would only apply to the Rankine type, and so not to steep waves in deep water. In shoal water, where the vertical acceleration is relatively lower, it would presumably be roughly applicable to waves of greater steepness; but whether it would be so up to breaking point, even when the beach is steep, is another matter. It leads to the results that $v_{as}/V = \pi S.\coth\frac{2\pi D}{L}$, and $v_{as}/V_0 = \pi S$; and the former gives $\pi S = \tanh\frac{2\pi D}{L}$ when breaking starts. It is merely intended to afford a primitive aspect of the circumstances of breaking, and a standard for comparison when the effect of distortion from trochoidal profile has to be allowed for, as described below.

Before leaving the subject of curlers, it will be useful to summarize the factors which may contribute towards their formation, for some of these factors may also apply to other types of breakers:

(*e*) Steepening of the crest owing to distortion, with accompanying increase in v_{as}.

(*f*) Steepening of the wave front, in so far as the wave may be approaching the 'long' state.

(*g*) Reduction in v_0 owing to ground friction.

(*h*) Reduction in v_0 owing to backwash.

(*j*) v_{as} being greater than the water speed lower down, owing to the wave not having become completely 'long'.

(*k*) The water at the surface, no longer held back by any immediately ahead, being able to cascade in a parabolic path, when it succeeds in outrunning the water lower down.

When S_0 is small, factor (*f*) may tend to predominate, D/L then being small as well. Thus bore conditions start to develop, the front of the crest becoming steeper and steeper, and the water in the crest, from surface to ground, all moving forward at roughly the same speed. Ultimately, the crest tends to become a travelling wall of water, and when it ceases to find any water in front to afford support, it collapses into surf. That seems to be the way in which breakers of class (*b*) develop, at all events when the waves manage to survive until they can break on an almost dry beach, which they often do when S_0 is small.

If shoaling is gradual, and S_0 is not small, increase in v_{as} due to distortion may result in premature breaking, with H/D measurably less than 2. As waves with large S_0 are those which really matter, and as the critical value of H/D at which such waves start to break is of practical consequence, it is worth considering in detail the circumstances which may affect this ratio. Gaillard[10], who took many measurements to ascertain its value, wrote:

(*l*) "With this relation established, it will be possible, in many cases, to determine in advance the maximum wave which will assail a given structure". For, naturally, if the soundings cause the heavier seas to break away from the shore, only the remains of their energy will reach the structure.

(*m*) He might have added that, in similar circumstances, some measure of protection would be afforded to inshore anchorages;

(*n*) and that as breaking across a harbour entrance makes the harbour inaccessible, quite apart from any question of draught, H/D determines the state of the tide at which it becomes safe to enter; or, for a tideless sea, the depth of dredging necessary to keep the entrance always open.

Now Gaillard found that, in still air, breaking started, on the average, with $H/D = 0{\cdot}5$, if the slope of the bottom was 1 in 12, but ranged up to $H/D = 1{\cdot}0$ for a slope of 1 in 100. He accounted for this by suggesting that with slope 1 in 12, undertow would acquire greater speed, and so hasten breaking; but with gradual shoaling there is usually more than one line of surf, and there can scarcely be undertow at the outer line, where breaking starts. It is true that he also refers to Airy's theory as to the effect of rapid change in depth[6], but not in this connexion, presumably because he considered that its effect here would probably be small. But the point should not be entirely lost sight of, for some definite explanation is surely called for, Gaillard's measurements giving results directly in conflict with Airy's theory of 'long' waves[11]. That theory seems to indicate that with gradual shoaling distortion should, so to speak, be cumulative, in the sense that it would continue to increase even if, at some given stage, shoaling were to cease. In that case breaking should start with smaller H/D if the slopes are flatter, and not steeper, as Gaillard found. It looks as if the question calls for further explanation.

But Gaillard also found that "for a given locality and a given slope—with a strong wind blowing in the direction of wave travel", $H/D = 0{\cdot}8$; "while with an equally strong wind blowing in the contrary direction", $H/D = 1{\cdot}4$. He does not specifically give the slope, but from the context it was probably 1 in 100.

This may, to some extent, be accounted for by the direct effects of a favourable wind, in tilting the crest, and speeding up the surface water, but as already hinted, this could scarcely explain such a large change in the critical value of H/D, and so the possibility of secondary waves constituting the main reason has been looked into. Such waves could only be present with an onshore wind, for with the wind off the shore, the fetch between beach and outer line of breakers would be too short for them to develop, even if the surf did not wipe them out as soon as they started to form.

But when dealing with waves having S_0 and H/D both fairly large, so that D/L is neither very large nor very small, one is confronted with the initial difficulty that no theory seems to have been evolved to show how such waves should behave; so the expedient of assuming trochoidal state in the first instance, and then considering the general consequences of distortion, has to be adopted. For trochoidal waves at the three stages, $H/D = 0{\cdot}8$, $H/D = 1{\cdot}4$, and after fully deferred breaking, the conditions would be as shown below:

S_0		0·05			0·025			0·01	
H/D	0·8	1·4	1·88	0·8	1·4	1·93	0·8	1·4	1·97
D/L	0·105	0·08	0·071	0·075	0·060	0·052	0·05	0·04	0·036
S	0·085	0·115	0·135	0·06	0·085	0·10	0·04	0·055	0·07
v_{as}/V	0·46	0·76	1·00	0·43	0·73	1·00	0·405	0·705	1·00
v_{as}/V_0	0·27	0·36	0·42	0·19	0·265	0·32	0·125	0·18	0·22
Diff.		0·095	0·06		0·075	0·05		0·055	0·04

So with $H/D = 1{\cdot}4$, v_{as} would be deficient to the extent of 25–30 per cent of V; and as there cannot be any secondary waves with this critical value, the cause must be ascribed to distortion. In other words, distortion makes good the deficit. When the critical figure is only 0·8, additional deficits of just 30 per cent have to be accounted for.

These percentages are based on V, which, being dependent on D/L, is a variable quantity. So, to see whether the extra deficits can be covered by the effect of secondary waves, it will be convenient to take V_0, which is a fixed figure, as the basis for percentage. Then the percentage deficits for $H/D = 1{\cdot}4$ become 6, 5, 4, but are increased to 15½, 12½, 9½, when H/D is only 0·8. But with $H/D = 0{\cdot}8$, the waves will not be so distorted as later on, with $H/D = 1{\cdot}4$; so secondary waves will have to account for percentages not definitely determinable, but certainly lying between 15½, 12½, 9½, and 9½, 7½, 5½.

Now the expression governing variation in steepness of secondary waves shows that when $D/L = 0{\cdot}105$, $0{\cdot}075$, $0{\cdot}05$, as it will do when the critical value of H/D is only 0·8, $S'/S'_0 = 3{\cdot}45$, $3{\cdot}05$, $2{\cdot}8$, and distortion would make it larger still. So as the secondaries are deep water waves, and will, therefore, break when $S' = 0{\cdot}13$, S'_0 would only have to be 0·038, 0·043, 0·046. These are quite moderate figures, and with distorted primaries they would not even have to be so large. So there is always the possibility of a comparatively substantial secondary breaking on the crest of the primary, and so causing local breaking of the primary, which once started will extend in both directions along its crest. That effect is quite normal. It is not so usual for a long stretch of crest to start breaking all at once, but a large number of quite small secondaries could cause it to do so, if their effect would not be too superficial.

In regard to the other, but less likely, possibility of breaking being started by secondary water-speed supplementing that of the primary, $v'_{as} = 2{\cdot}9\sqrt{L'}$ at breaking point[12], and whether the secondaries be of moderate length or very short, say $L'_0/L_0 = 0{\cdot}05$, or 0·01, the values of v'_{as}/V_0 calculated on that basis work out at almost exactly 0·2, 0·15, 0·1 for all three values of S_0, and so will cover the percentages to be accounted for. But it must be remembered that distortion of the primary reduces L', and so V', with the result that v'_{as}/V_0 may not be so large; so the earlier suggestion is in every way to be preferred.

It should be pointed out that secondaries steep enough to break when they are on the crest of a primary will only be conspicuous in that position, and that one must not expect to see them prominent throughout the length of the wave. The profile of an undistorted primary with small D/L would be an elliptic trochoid (tracing curve an ellipse), which is merely an ordinary trochoid (tracing curve circular) drawn with vertical scale reduced, in the present case, in the ratio $H : a_s$, that is, $\tanh \frac{2\pi D}{L} : 1$. So the fraction of the length of wave occupied by the crest, as measured at mid-height (orbit centre level), is $0{\cdot}5 - S.\coth \frac{2\pi D}{L}$, or almost exactly 35 per cent when $H/D = 0{\cdot}8$, whether S_0 be large or small, and distortion will make it still less. Since S'' will only vary from 0·025 to 0·035, the secondaries in general may almost pass unnoticed.

Discussion on shore breakers can scarcely be regarded as complete without a note on the circumstances which cause reflexion instead of breaking. The subject is in a rather indefinite state, except as regards the tidal wave, which is always reflected unless the conditions favour development of a bore. The reason seems to be that, with the tidal wave, $v_{as} = v_0$, and that its component towards the shore is always small; and with the whole body of water, from surface to bottom, moving shorewards quite slowly as a stream, breaking cannot possibly take place under normal conditions. Alternatively, for 'long' waves, and so for tidal ones, $v_{as}/V = \frac{1}{2}H/D$, while the condition for breaking is that v_{as} should equal V. Then, if D be taken as the local inshore depth, the inference would be that the tidal wave should break, even on an open coast. As that does not happen, reflexion must depend on some other condition, and the answer seems to be that it will always take place with the tidal wave, unless S is large. This also gives the clue for wind-formed waves.

For reflexion of wind-formed waves, v_{as}/V must be less than 1 at the shore, and so less than $\pi S.\coth\frac{2\pi D}{L}$. That, again, indicates that S should not exceed some given figure, if reflexion is to be ensured. That figure will undoubtedly be small for all but quite steep slopes. One cannot go further with certainty, and no observations seem to have been recorded to indicate what slopes, according to the values of S, will constitute border-line conditions. Chief interest lies in two rather conflicting requirements, for shore breaking inside a harbour contributes to quiet water, while elsewhere it may result in damage.

Reference has been made to the possibility of waves attaining the 'long' state before they start to break, if S_0 is small enough. Such waves may be of practical consequence, as, for example, on the Guinea Coast, where comparatively heavy surf can result from swell that may be only just discernible in deep water; but what follows refers more particularly to a phenomenon which may be noticed at suitable places, such as Minehead[13], where low but sharply crested waves are apt to emerge suddenly from an apparently quite flat sea, and rapidly become conspicuous, but break almost immediately after doing so.

To arrive at definite figures, it will be assumed that breaking starts when H/D has increased to unity; and as $H/D = S_0 \times H/H_0 \div D/L_0$, where H/H_0 is a definite function of D/L_0, the value of the latter ratio when breaking starts must be dependent on S_0. Further, D/L is a function of D/L_0, and shows the extent to which the waves have changed their state from deep water to 'long' on account of shoaling. Elaboration of the table in ref. 7 gives the following rounded-off figures when H/D is unity:

D/L_0	0·05	0·04	0·03	0·02	0·01	0·0075
D/L	0·094	0·083	0·072	0·058	0·040	0·035
$\frac{d(S/S_0)}{d(D/L_0)} \propto$	20	35	60	130	450	800

As the value of D/L_0 to which the waves can survive intact works out at, roughly, 0·05, 0·03, 0·014, 0·0075, when $S_0 = 0·05, 0·025, 0·01, 0·005$, only a low swell can reach the stage at which dS/dD starts to increase rapidly. But once it does so, the rate shoots up so rapidly that sudden emergence from an apparently flat calm becomes almost inevitable; and the figures show that when this happens the waves have already become 'long', in which case dS/dD would be proportional to $D^{-7/4}$. Under extreme conditions, emergence is deferred almost up to the water's edge, and thus the common occurrence of a quite calm sea just lapping on the beach for no readily apparent reason is really a logical outcome of the trochoidal theory of waves.

Thanks are due to Mr. N. F. Barber for examining and discussing the drafts of these notes, and for his advice, which has been embodied therein.

[1] *Nature*, **148**, 226 (1941).

[2] *Nature*, **149**, 219 (1942).

[3] *Nature*, **149**, 219 (1942).

[4] Stokes, "Math. & Phys. Papers", 1, 227.

[5] *Nature*, **148**, 226 (1941).

[6] Airy, "Ency. Metropolitana", 5, "Tides and Waves", art. 248.

[7] Airy, "Ency. Metropolitana", art. 249.

[8] *Nature*, **149**, 585 (1942).

[9] *Nature*, **150**, 582 (1942).

[10] Gaillard, "Wave Action", 1st ed., 114–123.

[11] Lamb, "Hydromechanics", 6th ed., 280.

[12] Wilton, *Phil. Mag.* (6), **26**, 1055 (1913); and Lamb, "Hydromechanics". 6th ed., 418.

[13] *Nature*, **151**, 480 (1943).

ELEMENTS AND THEIR ISOTOPES

THE Ritchie Lecture for 1945 of the Royal Society of Edinburgh was delivered by Dr. N. Feather (then at the Cavendish Laboratory, Cambridge, and now professor of physics at the University of Edinburgh), who took as his subject "The Number of the Elements". The lecture has now been published (*Proc. Roy. Soc. Edin.*, A, **62**, Pt. 2, 211; 1946). Prof. Feather commenced by tracing the development of the idea of the chemical element from its earliest beginnings until, in the last quarter of the nineteenth century, Mendeléeff's Periodic Table became accepted as fundamental. Further elucidation of the Periodic Table had to wait for the emergence of the nuclear model of the atom as described by Rutherford in 1911. This led to the Bohr quantum theory, Moseley's work, Soddy's idea of isotopy and Aston's mass analysis. Physicists found that the nucleus could be adequately specified by two parameters, Z and A: the former, the atomic number, is a measure of the positive nuclear charge, and the latter, the mass number, the nearest integer to the number expressing the mass of the corresponding neutral atom in terms of chemical oxygen as 16. The elements were defined and distinguished by their Z-values. By 1932 nearly all the different atom types had been identified and classified according to their Z- and A-values. In 1932, Chadwick discovered the neutron ($Z = 0$, $A = 1$), and the nuclear picture was much simplified by regarding the nucleus as made up of heavy particles, neutrons and protons ($Z = 1$, $A = 1$). The mass defect, or $1/c^2$ times the energy of binding of the nucleus, can be estimated as the difference in mass between that of the actual nucleus and of its constituent protons and neutrons taken separately. It is important to note that the mass defect increases approximately linearly with A; and that this, together with other known facts, leads to the conclusion that intra-nuclear forces show saturation with the α-particle as the quasi-saturated unit.

Prof. Feather then went on to consider the stability of nuclei. Certain values of A and Z are not represented among the elements. The reason for these omissions, which has been borne out by the experimental work of the last decade, is that the missing nuclei, like the elements with Z greater than 83, are all spontaneously radioactive, with the result that they have disappeared entirely, with the lapse of time, from the terrestrial globe. Artificial radioactivity, obtained by irradiating materials with α-particles, neutrons, protons, deuterons, electrons and high-energy X-radiation, and a study of the energy of the radiations emitted by these artificially radioactive substances, have demonstrated the extent to which the missing nuclei are unstable. For naturally radioactive substances disintegration occurs by the emission of α-particles or of β-particles; but for the artificially radioactive substances, only β-emission, but of two types, has so far been found to occur. Discussing this point, Prof. Feather shows that, for Z less than 84, the problem of the number of the elements, or of the number of stable nuclear species, turns essentially on the question of stability towards β-disintegration.

For Z greater than 83, the customary assumption that the onset of α-instability prevents stable species is not at all satisfactory. In 1939 neutron-induced fission was discovered, and in the following year, I. S. Petrzhak and G. N. Flerov (*J. Phys. U.S.S.R.*, **3**, 275; 1940) showed that, in the natural state, uranium undergoes fission spontaneously; for every million atoms of uranium which disintegrate with the emission of α-particles, roughly one divides spontaneously into two fragments. The probability of disintegration per unit time depends very markedly on the difference between the available energy (some 170 million electron volts for uranium) and an energy characteristic of the original nucleus and the fragments into which it divides. On a simple liquid-drop model, spontaneous fission can be shown to increase extremely rapidly in probability as Z^2/A increases, so that for Z greater than 92, spontaneous fission is practically instantaneous, leaving uranium the last terrestrially known element of the Periodic Table.

Finally, Prof. Feather discussed the limitation to the number of stable or quasi-stable isotopes of a given element, that is, the limitation to the A-values for a given Z. By examining the way in which the α-disintegration energy (or the decay constant) varies with the mass number for a particular Z, it is established that the limitation is essentially a question of the relative probability of α-emission to β-emission (either positive or negative electron emission).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, February 17

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. H. J. Fleure, F.R.S.: Clayton Memorial Lecture.

Sheffield Society of Engineers and Metallurgists (at the Royal Victorial Station Hotel, Sheffield), at 6.15 p.m.—Dr. N. P. Allen: "Metallurgical Aspects of Compressed Gas Cylinders".

Institution of Mechanical Engineers, Graduates' Section (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. Ian S. Porter: "The Art and Mechanism of Weaving".

Tuesday, February 18

Institution of British Agricultural Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. H. P. Hall: "Milking Machines".

British Society for International Bibliography (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Mr. W. C. Berwick Sayers: "The Organization of Information for the General Public"; Miss E. Taylor: "The Bureau of American Bibliography at the National Central Library".

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Prof. S. P. Bedson, F.R.S.: "Laboratory Investigations in the Diagnosis of Virus Infections of Man".*

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Colonel J. G. Robertson: "Recent Agricultural Development in Canada" (Neil Matheson McWharrie Lecture).

Society of Chemical Industry, Agriculture Group (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. E. W. Russell: "Present-day Views on Soil Cultivation".*

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m. and 5.30 p.m.—Dr. A. Nadai: "The Flow of Metals under Various Stress Conditions" (James Clayton Lecture).

King's College, Strand, London, W.C.2, at 5.30 p.m.—Prof. J. T. Randall, F.R.S.: "A Physicist's Approach to Biology".*

Institute of Petroleum, Northern Branch (at the Engineers' Club, Albert Square, Manchester), at 6 p.m.—Mr. A. E. Hope: Illustrated Dissertation on the "Use of Petroleum Additives".

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Discussion on "Radio Modulation Methods—Amplitude, Phase, Frequency and Pulse" (to be opened by Mr. G. Dawson, D. Deacon and R. F. Howard).

Society of Dyers and Colourists, Huddersfield Section (at Field's Café, Huddersfield), at 7.30 p.m.—Mr. G. E. Bedford: "What Happens at the Dry Cleaners".

Institute of Physics, Scottish Branch (at the University, Glasgow)—Mr. A. J. Maddock: "Dielectric Heating".

Wednesday, February 19

Physical Society (in the Jarvis Hall, Royal Institute of British Architects, 66 Portland Place, London, W.1), at 3 p.m.—Meeting to discuss the formation of an Acoustic Group. Dr. Alex Wood: "The Contribution of Acoustical Science to Allied Studies".

Chemical Society (joint meeting with the Royal Society of Arts, at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Sir Harold Hartley, F.R.S.: "A Century of Chemistry".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Microscopical Society (in the Hastings Hall, British Medical Association, Tavistock Square, London, W.C.1), at 5 p.m.—Mr. E. Wilfred Taylor: "The Practical Application of Phase-Contrast to the Biologist's Microscope"; Dr. A. F. W. Hughes: "Phase-Contrast Films of Tissue Cultures". (Discussion to be opened by Prof. L. C. Martin).

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. Davies: "The Design of High-Fidelity Disc-Recording Apparatus".

Institution of Civil Engineers, North-Western Association (joint meeting with the Liverpool Engineering Society, at the Municipal Annexe, Dale Street, Liverpool), at 6 p.m.—Mr. J. C. King: "The Static and Dynamic Testing of Aircraft".

Royal Institute of Chemistry, London Section (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Dr. G. H. Lees: "British Oilfields and Oil Exploration".

Thursday, February 20

Institute of Fuel, North-Western Section (at Radiant House, Bold Street, Liverpool), at 2.30 p.m.—Dr. E. G. Ritchie: "A Review of the Work of R/16 Committee".

Institution of Mechanical Engineers (at the College of Technology, Sackville Street, Manchester 1), at 2.30 p.m. and 5 p.m.—Dr. A. Nadai: "The Flow of Metals under Various Stress Conditions" (James Clayton Lecture).

Royal Society of Arts, India and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Lewis L. Fermor, F.R.S.: "The Value of Geological Survey in India's Economic Development".

Chemical Society (in the Chemistry Lecture Theatre, The University, Liverpool), at 5 p.m.—Prof. E. L. Hirst, F.R.S.: "Recent Developments in the Chemistry of Starch and Glycogen".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Herbert S. Sichel: "An Experimental and Theoretical Investigation of Bias Error in Mine Sampling, with special reference to Narrow Gold Reefs".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. M. Turing: "The Automatic Computing Engine".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. R. Mortlock and Mr. C. M. Dobson: "Neutral Earthing of Three-Phase Systems, with particular reference to Large Power Stations".

Chemical Society (in the large Chemistry Theatre, University College, Nottingham), at 7 p.m.—Prof. E. G. Cox: "Crystal Analysis and Stereochemistry".

Textile Institute, Yorkshire Branch (at the Midland Hotel, Bradford), at 7 p.m.—Prof. J. B. Speakman: "Proteins and Plastics".

Women's Engineering Society (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—"Plastics".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Chemical Society, Society of Chemical Industry and Royal Institute of Chemistry, Edinburgh and East of Scotland Sections (at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Dr. Neil Campbell: "Fluorescence".

Textile Institute, Belfast Branch (at the College of Technology, Belfast), at 7.30 p.m.—Dr. F. C. Wood: "Recent Developments in Cellulose and Wool Science and Technology".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 8 p.m.—General L. M. J. Van Hoof: "Trypanosomiasis in the Belgian Congo" (Second Chadwick Lecture).

Friday, February 21

Association of Applied Biologists (in the Main Lecture Theatre, Huxley Building, Exhibition Road, London, S.W.7), at 2 p.m.—Annual General Meeting. Dr. C. B. Williams: "The Field of Research in Preventive Entomology".

Chemical Society (joint meeting with the University College of Southampton Chemical Society, in the Physics Lecture Theatre, University College, Southampton), at 5 p.m.—Sir Ian Heilbron, F.R.S.: "The Chemistry of Vitamin A".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. D. Owen: "Quantitative Tests on Finished Mouldings".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. L. Diamond: "The Development of Locomotive Power at Speed".

Institute of Physics, Industrial Radiology Group (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. W. L. Harper: "The Organisation of Aircraft Radiology during the War".

Society of Dyers and Colourists, Manchester Section (in the Lecture Theatre, Gas Department Showrooms, Manchester), at 6.30 p.m.—Mr. G. S. Egerton: "The Aspect of Light on Dyed and Undyed Cotton".

Institute of the Plastics Industry, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—"Costing and Estimating of Mouldings, Compression, Injection and Transfer".

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 7 p.m.—Mr. G. Dakin: "Researches in Spinning and Doubling".

Textile Institute, Dublin Branch (at the Mansion House, Dublin), at 7.30 p.m.—Dr. F. C. Wood: "Recent Developments in Cellulose and Wool Science and Technology".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. M. L. Oliphant, F.R.S.: "Problems and Techniques of Modern Nuclear Physics".

Saturday, February 22

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. V. G. Jenner: "Fuel Economy in a Small Factory".

Nutrition Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1)—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Clinical Chemist to be responsible for tests and investigations of a chemical nature in the Clinical Pathology Department—The Secretary, University College Hospital Medical School, University Street, London, W.C.1 (February 28).

Chemists (2) for Research Scholarships, and a Chemist for a Research Fellowship, in connexion with fundamental work on the oxidation and constitution of coal—Prof. S. G. Ward, Department of Chemical Engineering, The University, Edgbaston, Birmingham 15 (February 28).

Lecturer in Fuels or Fuels and Refractories—The Secretary, The University, Edmund Street, Birmingham 3 (February 28).

Veterinarians to specialize in Poultry in the New Zealand Department of Agriculture—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (February 28).

Lecturers (2, men or women) in Mathematics—The Registrar, University College, Southampton (February 28).

Lecturer in the Department of Mathematics—The Registrar, Queen Mary College, Mile End Road, London, E.1 (March 6).

University Photographer—The Registrar, The University, Leeds 2 (March 15).

Principal Scientific Officer (Electrical Engineer), and a Principal Scientific Officer (Physicist) in the Royal Aircraft Establishment of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1797 (March 15).

Senior Experimental Officers (8) at the National Gas Turbine Establishment of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1794 (March 15).

Superintendent of Engineering Services, and a Superintendent of the Chemical Engineering Division, at a research establishment of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1795 (March 15).

Senior Engineer at the National Gas Turbine Establishment—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1798 (March 15).

Research Assistant in the Department of Botany—The Registrar, The University, Leeds 2 (March 31).

Technical Development Officer—The Establishment Branch (Room 266), Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1 (March 31).

Lecturer in Physiology—The Secretary, Queen's University, Belfast (May 1).

Associate and Full Professorships in the Department of Physics—The Head of the Department of Physics, University of British Columbia, Vancouver, B.C., Canada (May 12).

Assistant Biochemist—The Medical Superintendent, Dudley Road Hospital, Birmingham 18.

Lecturer in the Department of Electrical Engineering, and a Lecturer in the Department of Mechanical Engineering—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Information Officer (graduate in engineering or metallurgy, experienced in welding practice)—The Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

Biochemist or Chemist for research on fundamental problems related to the nervous system—The Director, Neuropsychiatric Research Centre, Whitchurch Hospital, Cardiff.

Laboratory Assistant (female) for chemical and spectrographic laboratory—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Journal of the Institute of Metals. Vol. 71, 1945. Edited by N. B. Vaughan. Pp. xliii + 670 + 48 plates. (London: Institute of Metals, 1945.) [411

Metallurgical Abstracts (General and Non-Ferrous). Vol. 12, 1945 (New Series). Edited by N. B. Vaughan. Pp. xi + 512. (London: Institute of Metals, 1945.) [411

Department of Scientific and Industrial Research: Road Research. Bulletin No. 4: Soil Survey Procedure and its Application in Road Construction. By A. H. D. Markwick and S. B. Webb. (Issued in co-operation with the Ministry of War Transport.) Pp. iv + 27. (London: H.M. Stationery Office, 1946.) 9*d*. net. [411

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FREEDOM IN DEMOCRACY

SCIENCE, like British democracy, as Mr. Alderton Pink emphasizes in his stimulating little book, "The Challenge to Democracy"*, has grown up in association with religious freedom, from which sprang freedom of thought, of the Press, of teaching, of assembly—of all that we understand as cultural freedom—as well as economic freedom, though he might well have added that neither the implications nor the responsibilities of even comparative economic freedom appear to be appreciated. The issue between science or democracy itself and any kind of authoritarianism turns on the principle that the spiritual life of the individual is a region in which the State is not competent to interfere; to that extent the control of science by any outside body would eventually strangle science. In maintaining its autonomy science can play a decisive part in preserving such freedom as man has gained hitherto, and even help to enlarge it. But to do this, science must enlarge its conceptions of truth and clarify its conceptions as to the area of liberty. Such books as Prof. F. A. Hayek's "The Road to Serfdom" may conceivably have hindered rather than helped the fundamental thinking on this point that is a primary need, and Mr. Alderton Pink's chapters are by contrast a welcome stimulus. Provided cultural freedom is preserved, the democratic State is not undermining its own principles by undertaking the control of economic affairs. We must, it is true, recognize that the traditional liberty of the individual will be affected to a considerable extent, but the present alternative to serfdom is surely a system of public control under which lesser liberties are sacrificed in order to secure the greater.

The danger to which Prof. Hayek has directed attention must nevertheless not be belittled, and it is essential that the community as a whole be allowed to decide to what extent planning operations are to be allowed to encroach on individual liberties. That is as true of planning in the scientific field as in the wider field; but the scientific community must decide its own limitations, and the danger of outside control will disappear as the education of the whole community advances. We need a re-statement of the democratic principles of liberty of thought and expression. While we must preserve at any cost the freedom to publish in all sincerity the political, the artistic or the religious faith we hold, and to persuade others to accept that faith; the freedom to pursue research into any branch of human knowledge for the advance of science and scholarship; and the freedom to give expression to thought and feeling for the purposes of art, the governing motive cannot be disregarded. The freedom we guarantee must be freedom to act with a worthy purpose.

Mr. Pink develops his argument here with reference to the dangers attendant on some of the abuses of cinema and Press, and he argues that public supervision can be combined with genuine professional freedom and independence. The particular methods of securing such a balance have to be worked out by the democratic communities if they are to promote a healthy cultural life, and this is one of the problems that confronts the scientific community at the present time. Its complexity is well illustrated by the discussion provoked by Sir Robert Robinson's recent commendation, in his anniversary address to the Royal Society, in regard to the independence of the universities and unfettered freedom of research, and the refusal of many universities to accept theses that cannot be published.

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* The Challenge to Democracy. By M. A. Pink. Pp. 118. (London: Faber and Faber, 1946.) 10*s*. 6*d*.

What has to be recognized in this matter is that the positive government which is implied in a social security State and in conditions of full employment is not only bound to curtail the economic freedom of the individual to some extent; but it also involves obligations on the part of the worker, as well as of the employer and the State. Mobility of labour and abrogation of the right to withhold labour are within reasonable limits part of the price which has to be paid for social security, with all its implications for cultural freedom; and unless that price is paid, social security and much with it will collapse.

Science cannot be pursued entirely regardless of the material needs of mankind. That future depends rather on the man of science helping the community in which he works to understand his primary loyalty to the search for truth, the method by which he secures his results and the price which has to be paid for them; and in co-operating with the community in the defence of the freedom of the other cultural activities of mankind.

That, however, is only part of science's contribution to the defence of freedom and of the evolution of a new world order. An equally important contribution is that which Dr. G. H. Monrad-Krohn has indicated in his address "*Homo sapiens* and the Peace Problem: a Plea for a more Comprehensive Survey"*. Before we build a new world order that will ensure international peace, we must know very much more about the difficult country across which the road to peace must be laid. We must understand not merely the ethical demands which an international society makes, but also a great deal more about the psychological peculiarities of mass mentality that constitute so serious a threat to a rational order.

Dr. Monrad-Krohn sets forth the contribution which psychology, and especially social psychology, has to make. He urges that institutes should be created for the study of problems in social psychology, with the dual purpose of research and the exposition of its results. Nor would he confine the study of social psychology to the universities: it should begin in the schools and should be obligatory for all politicians, school-teachers and journalists. He thinks that the leading people in broadcasting and in the cinematograph world should have a knowledge of mass psychology, so as to enable them to realize their great responsibilities. His attitude to the Press, broadcasting and the cinema, advocating full freedom under full responsibility, is similar to that of Mr. Alderton Pink. He is under no illusions as to the pace of advance. Social psychology, although of steadily increasing importance, is still in its youth; but this highly stimulating paper makes constructive suggestions for a programme to avert the great dangers which at present confront us, and to repair the moral deterioration which any war inevitably entails.

The plea for attention to psychological as well as technical factors in the rebuilding of the world is not to be set lightly on one side; and Dr. Monrad-Krohn is also fully aware that while this educational campaign is proceeding, not merely binding international legal arrangement but also a heavily armed international police force and a very close control of armaments everywhere will be essential. But he does point a way forward that must be explored, and he indicates a contribution which the man of science can, as citizen, do something to promote.

What needs to be remembered is that the elimination of war as a means of dealing with international disputes and the development of a world order, as indeed of an ordered State, demand not merely improvements in the efficiency of government, but also a positive contribution from the individual citizen in the form of the discharge of certain responsibilities. Social psychology may come indeed to make a vital contribution to that intelligence system which is so essential an element in the integration of national, local and sectional interests into policy and a plan of action conceived and accepted by all. But a new spirit is required to vitalize the body politic—a unifying purpose as well as a habit of responsible criticism—if men and women are to be capable of accepting the sacrifices, at every cultural, social or economic level, which a properly planned democratic order must continually demand in the interests of the whole.

While his approach is different, that is also a main theme of Mr. W. A. Gauld's "Man, Nature and Time"*. He insists that man rather than Nature gives direction and purpose in history, and that the world as we experience it to-day is a man-made world to a much greater degree than we allow; then he challenges outright much of the pessimistic thought to-day and the tendency to drift. He presents a picture of a dynamic world, emphasizing its complexity and interrelations in much the same way that Dr. Barlow did in "The Discipline of Peace", rejecting the physical determinism which accounts for events by conditions. It is a challenge to thought as well as to action, and although he points less clearly to the moral factors than Mr. Pink, Mr. Gauld is equally convinced of the importance of spiritual values and the necessity for a moral basis for the world order which he sees as in the nature of things and not merely as an idealist concept.

There is a realism and a confidence in this modest introduction to world study which are invigorating, and will be needed in the task of education to which Mr. Gauld also summons us. His book is indeed more challenging than Prof. Herman Finer's "The Future of Government"†, for it is only in the last chapter that Prof. Finer rises above a pedestrian chronicle of events and surveys the future task of democracy. In that chapter, however, he does something to justify the title of his book, and comments which elsewhere are overlaid with detail are seen in a truer perspective, even if there is little that is new.

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* *Homo sapiens* and the Peace Problem: a Plea for a more Comprehensive Survey. By Dr. G. H. Monrad-Krohn. Pp. iv+16. (London: H. K. Lewis and Co., Ltd., 1946.) 2*s*. 6*d*. net.

* Man, Nature and Time: an Introduction to World Study. By William Alexander Gauld. Pp. x+291. (London: G. Bell and Sons, Ltd., 1946.) 10*s*. 6*d*. net.

† The Future of Government: being a Continuation of the "Theory and Practice of Modern Government". By Herman Finer. Pp. ix+198. (London: Methuen and Co., Ltd., 1946.) 10*s*. 6*d*. net.

Prof. Finer, no less than Pink and Gauld, recognizes the influence on the present situation of deep individual complexities and insecurity regarding spiritual values; and he sees too that the threat to freedom comes, not only from dictators afraid of its consequences, but also from the sharpening of control by each nation over its scientific and technical community by such means as the Official Secrets Act, and pledges to an international organisation permitting an inspectorate full access to all plants. He voices explicitly the continuing anxiety whether the basic liberties, freedom of expression and debate, of change of government, of association and of impartial judgment before the courts can stand up against the high degree of organisation, self-control and the external controls involved in national and international organisation.

Prof. Finer has a clear view of what is at stake, both for science itself and for the democratic society in which it can best flourish, and the price to be paid is set down fairly. It is an unending task in science as well as in government to protect the open way for the communications of the gifted, and equally to maintain the proper conditions by which the multitude's reflexion upon them is promoted; and scientific men are at last coming to appreciate the dangers which have followed the neglect of the latter task. The relation of knowledge to power is an unending and ever-changing problem, and grows the more intimate as the knowledge needed for leadership, direction and decision in the world grows more complex. Effective democratic government, Prof. Finer observes, requires the interplay of the general body of citizens and the statesmen; not the exclusion of eminence but its contributive uses; and events at home and abroad are testifying to the truth of his further comment that the unity of a dynamic society is a product not simply of mass but of representative creativeness at a responsible centre, and that the fellowship which marks a nation in its progress is in part the product of men at the responsible summit who can relate the needs of the whole social situation to the fragmentary contending wants of millions of aggressive individuals.

Planning and organisation there must be in government, no less than in science, if chaos and waste are not to reign supreme. But beyond this there must be that vision, that sense of purpose, of moral and spiritual values that will give unity to its activities and draw together in harmony and fellowship the myriad units who pursue these activities or whose wants are satisfied by them. The major question for our time is whether this generation has the courage, imagination and will to master the modern social techniques and to guide them in the right direction, and on this point Prof. Finer is silent. We turn, therefore, to Dr. Monrad-Krohn, the late Prof. K. Mannheim and Mr. Alderton Pink for guidance and suggestions on developing the moral qualities of the peoples, and the changed attitude to education—and especially to adult education—which can alone cure the social diseases so evident and so widespread to-day. These can provide the ethical foundations for the new institutions and instruments of government, regional and functional, national and international, which mankind must evolve to safeguard its great cultural heritage. They can ensure the greater freedom of mind and culture, of communication and utterance in which alone science and the arts can flourish, and which to-day are so sinisterly threatened by the very powers which science has put into the hands of men to command.

NUCLEAR EXPLOSIVES, NUCLEAR POWER AND WORLD AFFAIRS

One World or None

Edited by Dexter Masters and Katharine Way. (Whittlesey House Publication.) Pp. xi+79. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 5*s*.

THE atomic bomb is one great cause of political uncertainty in the world to-day. Although the difficulty of reaching a satisfactory solution of the problem is largely confined to the relationship between the United States, the great Power which possesses the bomb, and the U.S.S.R., the other great Power of to-day which does not yet have stocks of the revolutionary weapon, the significance of the new discoveries is probably greatest of all for Great Britain and the Commonwealth. The concentration of industry and population in the cities of the British Isles, the island isolation which has been such an asset in the past, but which now prevents adequate dispersal or effective interception of fast aircraft, our dependence on sea communications and the very nature of our climate which offers cover to the raider, all combine to make us more vulnerable than any other industrial country. At the same time, the probability that atomic energy will provide abundant power which could counteract many of the disabilities of large parts of the Commonwealth, which are ill-endowed by Nature, means that we have a special positive stake in the elimination of the war-like uses of atomic energy and rapid development of all its peaceful applications.

The collection of essays in the book under review represents an early analysis of the situation from the point of view of American writers. The authors are some of the best-known men of our day in physical science, in military arts and in constructive journalism. Some of the articles are brilliantly written, and reveal the grave concern for the future of civilization and of science which is felt by all men whose thoughts go beyond the barriers of nationalism. The foreword is by that great scientific humanitarian, Niels Bohr, who, in the days before the bomb was dropped, taught all who worked with him how to think constructively about the political problems which use of the bomb would engender. Subsequent events have shown clearly how right he was and how sad it is that his ideas were ignored.

The technical facts about the bomb and its control and the peaceful possibilities of atomic energy are discussed by such brilliant scientific writers as Oppenheimer, Ridenour, Condon, Morrison, Einstein, Urey and Bethe, while General Arnold shows why, despite the claims of some interested parties to the contrary, the bomb and its future possibilities do make nonsense of great navies, great armies and air forces. It is clear that if preparation for war is to continue to be the principal peace-time preoccupation of men, the future lies with small highly trained specialist corps to disperse the new agents of destruction and to do what little is possible to intercept them and to counter their effects.

Almost all these writings can be translated readily to refer to the British Commonwealth. Much of the wisdom contained in them has been incorporated in the Lilienthal–Baruch plan for control of atomic energy, which is now under consideration by the United Nations. Since the end of the War, Oppenheimer, Urey and others in the United States have devoted their whole time to consideration of these problems, and behind anything constructive which has emerged lies the determination and great understanding of these men. Despite the greater urgency of the problem for us in Britain, no one here has emulated this achievement, probably largely because public activity by a man of science in Great Britain brands him at once as an 'awkward fellow'. During his recent visit Prof. Urey remarked that "there is a comparative lack of a sense of urgency here", and perusal of these articles from the United States may help to awaken a more vital interest.

In the absence of corresponding British documents, the U.S. "Smyth Report" and "One World or None" form companion books of information for all men of science who have feelings of responsibility for the effects of their work on world affairs.

M. L. OLIPHANT

RENEWAL OF A CLASSIC

The Common Sense of the Exact Sciences

By William Kingdon Clifford. Edited and with a Preface by Karl Pearson. Newly edited and with an Introduction by James R. Newman. Pp. lxvi+250. (New York: Alfred A. Knopf; London: Sigma Books, Ltd., 1946.) 15*s.* net.

THIS volume is the product of many minds. Clifford left the manuscript of "The Common Sense of the Exact Sciences" in a very incomplete state at his death in 1879, and the work of editing it for publication was entrusted to Prof. R. C. Rowe, who himself died in 1884 with his task unfinished. It was then taken in hand by Prof. Karl Pearson, and eventually appeared in 1885 and passed through various editions. An American publisher has now reprinted it, with a preface by Earl Russell and a 48-page introduction by Mr. James R. Newman, who has also added many footnotes.

The book has been so well known for generations —Russell tells us how he read it "with passionate interest" nearly sixty years ago—that a description in detail would be superfluous; all that is called for seems to be some comments on its general character and on the contributions of its latest editor.

Perhaps the only criticism that might be made of the original work was the disparity between different chapters, as regards difficulty of comprehension. The early part (that a sum is independent of the order of adding, a product is independent of the order of multiplying, and so forth) can be understood by a young child, while the treatment of, for example, the curvature of space, which comes later (though the ideas are explained with wonderful lucidity), calls for considerable intellectual power and some maturity of mathematical knowledge (indeed, I knew personally a university professor of natural philosophy, of the generation next above mine, who to the day of his death refused to believe in the possibility of non-Euclidean geometry). The reader is liable to be either bored by the laboured discussion of the obvious, or unable to grapple with the more advanced subjects.

The editor, Mr. Newman, has done his work well: his footnotes are admirable, and show both learning and judgment. But the situation was a difficult one; Clifford died before the modern theory of number was discovered and before his brilliant idea of geometrizing physics had been brought to its glorious fruition by Einstein; and to graft notions of these theories on his book was scarcely possible without complete re-writing. The effect of trying to do it is sometimes rather as if an explanation of the multiplication-table had notes warning the infant reader that the multiplication of quaternions is non-commutative.

EDMUND WHITTAKER

PHILOSOPHERS AND HISTORIANS

Leviathan or the Matter, Forme and Power of a Commonwealth, Ecclesiasticall and Civil

By Thomas Hobbes. Edited with an Introduction by Michael Oakeshott. Pp. lxvii+468. (Oxford: Basil Blackwell, 1946.) 8*s.* 6*d.* net.

The Second Treatise of Civil Government, and a Letter concerning Toleration

By John Locke. Edited with an Introduction by J. W. Gough. Pp. xxxix+165. (Oxford: Basil Blackwell, 1946.) 8*s.* 6*d.* net.

On Liberty and Considerations on Representative Government

By J. S. Mill. Edited with an Introduction by R. B. McCallum. Pp. lix+324. (Oxford: Basil Blackwell, 1946.) 8*s.* 6*d.* net.

Prophets and Peoples

Studies in Nineteenth Century Nationalism. By Prof. Hans Kohn. Pp. vii+213. (New York: The Macmillan Company, 1946.) 10*s.* 6*d.* net.

Politics and Morals

By Benedetto Croce. Translated from the Italian by Salvatore J. Castiglione. Pp. 138. (London: George Allen and Unwin, Ltd., 1946.) 8*s.* 6*d.* net.

THE seventeenth century, with its forcing ground of ideas during the Civil War and Commonwealth, can now, more clearly than ever, be seen as one of the decisive periods of modern history for England, and, through England, for Europe. The English Revolution, like its successors in America, France and Russia, which drew inspiration from it, has left an ineffaceable mark on world history. It is well, then, that at this time, when accusations of reaction and stagnation are in the air, we should be reminded of the pioneering work of the seventeenth century that has ensured three centuries of the steady development of what we recognize to-day as the British conception of democracy. One of the most daring and original minds of the revolutionary era was that of the philosopher, Thomas Hobbes, whose classic and long hotly debated "Leviathan" has now been re-issued for the student, with a striking introductory essay by Mr. Michael Oakeshott. It appears, properly enough, with John Locke's equally famous, and more obviously influential, "Civil Government", edited by Mr. J. W. Gough, and with John Stuart Mill's Victorian classics, "On Liberty" and "Representative Government", introduced by Mr. R. B. McCallum, the three volumes being the first of a new series of "Political Texts" which should win a high place in the esteem of the student of political philosophy.

Hobbes has so often been dismissed in recent times as an early "Fascist" that it is stimulating to find Mr. Oakeshott insisting on his individualism and on his opposition to absolutism and arbitrary rule: "Nor is . . . the Leviathan a designed destruction of the individual; it is, in fact, the *minimum* condition of any settled society among individuals. . . . Hobbes, without being himself a liberal, had in him more of the philosophy of liberalism than most of its professed defenders." To this view may be opposed a sentence from Dr. G. P. Gooch's British Academy lecture on Hobbes, delivered in 1940: "Hobbes was the foe of the idealism, the individualism, and the method of compromise which have given Western civilisation its colour and shape". With Mr. Oakeshott's clear and readable text before him, the student can form his own opinion and ponder the relevance of this undoubted masterpiece for the fundamental political and social problems of our own day. Above all, he can relish the force of Hobbes' statement, a challenge in its own day, that the State was formed for man, and not man for the State: "For by art is created that great LEVIATHAN called a COMMONWEALTH, or STATE, in Latin CIVITAS, which is but an artificial man; though of greater stature and strength than the natural, for whose protection and defence it was intended".

Locke has a less general validity; but as the apologist of the Glorious Revolution of 1688 his influence on English and American political development has been considerable, as Mr. Gough is concerned to show. "The end of government," Locke wrote, "is the good of mankind", and he drew a distinction between society and State, which Hobbes had confused, and thereby justified the English tradition of social activity apart from the State which was particularly fruitful in the nineteenth century, and created the political atmosphere in which J. S. Mill's work was conceived. "With the English-speaking peoples," says Prof. Kohn in an essay on Mill in "Prophets and Peoples", "the initiative rested with society, not with the state." Conditions have changed in eighty years, but the closing passage of "On Liberty" has still a real meaning and message: "A government cannot have too much of the kind of activity which does not impede, but aids and stimulates, individual exertion and development. The mischief begins when, instead of calling forth the activity and powers of individuals and bodies, it substitutes its own activity for theirs. . . . The worth of a State, in the long run, is the worth of the individuals composing it."

"Prophets and Peoples" is a collection of essays on various national and nationalist philosophers of the past century, Mill, Michelet, Mazzini, Treitschke and Dostoevsky. They are sound and thoughtful studies, which whet the appetite for Prof. Kohn's forthcoming study of nationalism during the period. But what is most striking as one reads the book is the change in mood and outlook as one passes from the three Western European thinkers to Treitschke and Dostoevsky: many of our recent difficulties are revealed in the contrast.

Prof. B. Croce has long been famous as the philosopher and historian of liberalism, and this most recent book, "Politics and Morals", consisting of essays written, apparently, before the War, re-states his faith in Western democracy on liberal foundations. "In the final analysis," he says, in words that recall Mill, "States are what the men who constitute them continually make them. . . . The liberal conception is not meant for the timid, the indolent and the pacifist; but wishes to interpret the aspirations and the works of courageous and patient, of belligerent and generous spirits, anxious for the advancement of mankind and aware of its toils and of its history." The emphasis, again, is on men, not institutions, and the moral is clear. MAURICE BRUCE

FRUIT GROWING

Hardy Fruit Growing

By Sir Frederick Keeble and A. N. Rawes. Second edition. Pp. xi+342+21 plates. (London: Macmillan and Co., Ltd., 1946.) 20*s*. net.

THE first edition of this book appeared in 1936; it is a testament to the distinguished authors that so little change has had to be made in this new edition. A few deletions of material now out of date, a new paragraph here and there to amplify some point in the light of new knowledge, more especially in the section dealing with cultivation and manuring, and a more extensive revision of the sections on the pests and diseases of individual fruits by Messrs. Fox Wilson and Green of the Royal Horticultural Society's laboratories, are all that have been found necessary.

The avowed primary object of the book, to provide amateur and professional gardeners with a sufficient guide to enable them to grow fruit well, is admirably achieved. The first half of the book, on planting, upkeep, propagation and storing, is meant to be read and, coming from the pens of two such able writers, is most eminently readable. It contains a great amount of factual experiential teaching; the only criticism one might make is that a writer such as Sir Frederick Keeble, who possesses to such a unique degree the gift of exposition of science to the non-scientific, might have dilated more on the physiological principles underlying the practice of fruit growing. To a greater and greater extent in these days the enthusiastic amateur wants to know the 'why' as well as the 'how', and few can explain it better than Sir Frederick. Many thousands will always remember with delight his popular scientific leaders of the *Gardener's Chronicle*, and will wish that more of that easy, intimate style could have been infused into the present work.

The second part is a reference section dealing with each of the main hardy fruits in turn, discussing varieties, pests and diseases, and special points of culture. In the selections of varieties for different purposes one sees the hand of the second author, than whom few know fruit varieties better. No one would quarrel with his choices, though perhaps more of the newest varieties of outstanding merit might have been included in this second edition. A notable example is the omission of the plum variety 'Marjorie's Seedling', one of the best all-round plums for private and commercial grower alike, though admittedly not of the very first quality for dessert flavour.

The sections on the pests and diseases of the separate fruits are admirable examples of succinct information without a wasted word; perhaps the use of D.D.T. is too new and experimental as yet to be included in a text-book of this kind, though its value in the control of apple blossom weevil, to take a single example, would seem to be so great as to have called for some mention, however cautious.

The last section of the book, dealing in an introductory way only with commercial fruit growing, is disappointing. It is too brief to be of any value to the established grower, yet too detailed to be interesting to the amateur. The inclusion of some simple physiology in the first section, as we have suggested, would allow of the omission of this part without loss to the value or size of the work. In particular, there seems no reason whatever for the chapter on the very specialized subject of forcing strawberries under glass. No other fruits under glass are dealt with, so why pick out this one example?

The public to whom the book is primarily addressed will, however, find all the practical information they can want within the book, and it will stand as one of the most valuable works on the subject.

R. H. Stoughton

BIOLOGY OF THE TREMATODA

The Trematoda

With Special Reference to British and other European Forms. By Dr. Ben Dawes. Pp. xvi+644. (Cambridge: At the University Press, 1946.) 52*s*. 6*d*. net.

Every teacher of biology will no doubt agree that we have for a long time needed a single volume which gives, in the English language, a detailed account of the trematodes written from the point of view of the biologist. The medical man and the veterinarian, confronted with the serious diseases which some species of trematodes cause, have at their disposal excellent accounts of these pathogenic species which necessarily lay emphasis upon the economic, therapeutical or epidemiological aspects of the problems which they raise. In these modern text-books of parasitology two developments are clearly revealed. One is that enormous advances have been made during recent years in our knowledge, not only of the trematodes, but of other helminths also. The second is that the men who gained this new knowledge quickly learned that parasitic organisms cannot be controlled unless they are first understood, and that they cannot be understood unless they are studied precisely as the biologist studies them, namely, as organisms inseparable from their environments and following a certain mode of life in relation to other living things. The parasitologist, therefore, who wishes to control or minimize the damage inflicted upon man and his civilization by parasitic organisms must be primarily a biologist; and nothing shows this more clearly than the fact that most of the advances which we have made in the control of parasitic organisms have been due to increases in our knowledge of their biology. Every modern text-book of parasitology recognizes this and devotes considerable space to the biological background upon which specialized information depends.

Dr. Dawes does not attempt to compete with these more specialized text-books of parasitology. His aim is rather to place at the disposal of everybody a much more detailed account of the biology of the trematodes than any text-book of parasitology could give. It is likely that the medical man and the veterinarian, well qualified by their experience to realize the extent of the service which he has done for them, will be among the first to echo his hope that British biologists will give more attention to the trematodes. Certainly, biologists will find in this book plenty of problems which require further study; for as the author himself says, they are indicated on almost every page and they are varied enough to occupy a variety of interests, whether these be physiological, biochemical, morphological or taxonomic. For those who like especially intricate problems requiring a knowledge of more than one branch of biology there are the problems of host relationships and the immunological problems associated with them.

The book begins with a chapter on the Platyhelminthes which places the trematodes in their zoological setting; it contains also a section on the derivation of the names of trematodes, which introduces the student to the mysteries of zoological nomenclature. The structure of the Monogenea and the Digenea is then described, and the next section, which occupies about half the book, is devoted to the classification of both these orders and to the characteristic features of their suborders and families. An immense amount of information is compressed into this section. Keys to the families are given, and there is a useful table of the general characters of the main families of the Digenea. A classification of the various kinds of cercariæ follows, and this is succeeded by chapters on the reproduction, geographical distribution and phylogeny of the trematodes and on their life-histories and the biology of their larval and adult phases. There is an interesting short historical account of work done on the trematodes, and useful notes are given on the collection, preservation, fixation and staining of both the larvæ and the adults. The book ends with a list of nearly 1,600 references to literature. The fact that only about half of these are in English is a measure of the relative amount of work done on trematodes in Britain and in other countries. Many of the papers mentioned are not readily accessible, so that the incorporation of their contents in the pages of this book is a useful service. The index is adequate; but it might be improved in the future editions, for which there will certainly be a demand.

Even a short review of this book cannot be concluded without a reference to the grace and simplicity of the author's style and to the excellence of the publishers' contribution to the making of the book. It may be argued that it is no part of the function of a scientific book to give pleasure to the reader; but the sufficient answer to that argument is the fact that many books written by men of science do give pleasure to their readers and are among the best examples that we have of English literary style and of British book-production. This is such a book, and the reason for it is possibly to be found in the author's statement that, after more than twenty years as a student and a teacher, he has not lost his wonderment at the phenomenon of parasitism. Wonderment? Is that the secret of it all? So long as we can feel that wonderment and can discover and foster it in the young people whom we teach, so long will science progress, and so long will understanding strengthen and humanize the contribution of science to the progress of mankind.

G. Lapage

A KINETIC THEORY OF LIQUIDS

By Prof. MAX BORN, F.R.S., and H. S. GREEN
University of Edinburgh

THE problem of formulating a rigorous mathematical description of the molecular motion in liquids has always been regarded as much more difficult than that of the kinetic theory of gases or of solids, because one has the simplifying features of low density in the case of gases, and of a regular lattice structure in the case of solids, while the molecules of a liquid are in a dense and disordered state. It is clear that only approximate solutions may be expected; but, in introducing the approximations, we think that the following principle should be accepted. The general equations should be established as rigorously as the present knowledge of the fundamental law permits; the solution of these equations may, however, be obtained by approximations suited to the case.

What is now the situation in the theory of liquids? It is true that a number of attempts have been made to solve special problems with the aid of devices appropriate to each particular purpose; these have been admirably summarized in a recently published text-book by Frenkel[1]. In the special case of equilibrium one has even a rigorous formulation of the general equations, namely, that obtained by applying the methods of statistical mechanics. If, here, the results are meagre, and no comprehensive equation of state is available, this is only because of the formidable mathematical difficulties in reducing and interpreting the formal solutions. It is quite different with the theory of liquids in motion; here no serious attempt to derive the dynamical and thermal equations from the point of view of atomistic theory is known to us[*]. Enskog[2] in his later work tried to derive a generalization of Boltzmann's equation which would apply to liquids; but owing to a wrong approach, the equation he obtained was still not quite correctly formulated, and contained besides an unknown function which he had no means of determining.

Yet all the fundamental conceptions and laws required for the purpose are known; in the domain of higher temperatures, we have Newton's laws of motion and the principles of statistics and probability, and for lower temperatures, their quantum analogues. The reason why this problem has never been properly tackled seems to lie in the fact that hitherto the engineers have been satisfied with ordinary hydro- and thermo-dynamics, and have had no need of an atomistic sub-structure, while the physicists, interested in atoms and the elementary particles (protons, neutrons, electrons, etc.), have preferred to study gases, where the atoms are almost isolated, or solids, where they act in harmony. However, the situation has changed during the last few years. On one hand, regularities in the values of the molar constants, like the coefficients of viscosity, diffusion and thermal diffusion, have been found, which need atomistic explanation. On the other hand, in low-temperature physics, atomistic and molar behaviour can no longer be separated. In particular, the phenomenon of superfluidity in liquid helium II defies classical hydrodynamics; it is a quantum effect of matter in bulk. All attempts to explain the apparent disappearance of viscosity below the λ-point of helium seem to be futile so long as the mechanism of viscosity in liquids is not known even for ordinary temperatures.

These were the motives which led us to formulate a general kinetic theory of dense matter. It will be published in complete mathematical detail in the *Proceedings of the Royal Society*; but as a period of time will elapse before the later papers of the series will appear, we shall give here a short account of our methods and results.

Comparing the kinetic theory of gases (which applies to dilute systems in equilibrium and in motion) with general statistical mechanics (which holds for any system in equilibrium only), one sees that in the first case a distribution function $f_1(t, x^{(1)}, \xi^{(1)})$ is used which depends on the time t, and the position vector $x^{(1)}$ and the velocity vector $\xi^{(1)}$ of a single molecule, while in the second case one has a distribution function $f_N(x^{(1)}, x^{(2)}, \ldots, x^{(N)}, \xi^{(1)}, \xi^{(2)}, \ldots \xi^{(N)})$ which depends not on time, but on the position and velocity vectors of all N particles of the system. These are obviously two extreme cases of a set of functions

$$f_1(t, x^{(1)}, \xi^{(1)}), f_2(t, x^{(1)}, x^{(2)}, \xi^{(1)}, \xi^{(2)},) \ldots, \quad f_N(t, x^{(1)}, x^{(2)}, \ldots, x^{(N)}, \xi^{(1)}, \xi^{(2)}, \ldots, \xi^{(N)}) \qquad (1)$$

where each function depends on the co-ordinates and velocities of a number of particles, indicated by the superscripts (1), (2), (3), ..., and time. Our first step consists of introducing this whole set of functions (1), which we call 'multiple distribution functions'.

The function $f_h(t, x^{(1)}, \ldots, x^{(h)}, \xi^{(1)}, \ldots, \xi^{(h)})$, multiplied by the product of the elements of space and velocity around each of the points, measures the probability of finding each of the volume elements occupied by molecules with velocities in the given velocity range. Now, the main feature of a dense assembly of particles is that the distribution function of order h is *not* a product of those of lower order; for example, $f_2(t, x^{(1)}, x^{(2)}, \xi^{(1)}, \xi^{(2)})$ is not equal to $f_1(t, x^{(1)}, \xi^{(1)}) f_1(t, x^{(2)}, \xi^{(2)})$. There are, however, obvious relations between consecutive functions; for example, by integrating f_{h+1} over the range of coordinates and velocities of the last particle, one obtains f_h, apart from a normalizing factor $(N - h)$.

We need also to generalize the conception of distribution function by taking as arguments for each molecule, not only the position and velocity vectors, but also the acceleration vectors $\eta^{(i)}$; these functions we write $g_h(t, x^{(1)}, \ldots, x^{(h)}, \xi^{(1)}, \ldots, \xi^{(h)}, \eta^{(1)}, \ldots, \eta^{(h)})$. If g_h is integrated over the ranges of the $\eta^{(i)}$, one obtains f_h, and if f_h is integrated over the $\xi^{(i)}$, one obtains the number density functions n_h, which depend only on the position vectors $x^{(1)}, \ldots, x^{(h)}$, and time. The condition that a group of h molecules preserves its identity in the course of the motion is a kind of multi-dimensional continuity equation for each of the functions n_h, f_h, g_h. The most important of these is the equation for f_h, which has the form

$$\frac{\partial f_h}{\partial t} + \sum_{i=1}^{h} \frac{\partial f_h}{\partial x^{(i)}} \cdot \xi^{(i)} + \sum_{i=1}^{h} \frac{\partial}{\partial \xi^{(i)}} \cdot (f_h \overline{\eta^{(i)}}) = 0. \qquad (2)$$

Here $\overline{\eta^{(i)}}$ is the mean acceleration of the molecule (i) obtained by averaging $\eta^{(i)}$ with the help of the distribution function g_h.

Now the main point of the theory is reached: this mean acceleration can be expressed in an alternative way, with the help of Newton's equations of motion.

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[*] (*Note added in proof.*) We are indebted to Prof. E. N. da C. Andrade for directing our attention to an important paper recently published by J. G. Kirkwood (*J. Chem. Phys.*, **14**, 180; 1946), in which he approaches our problem from the point of view of statistical mechanics and the Brownian movement, and succeeds in deriving our equation (2). In the work so far published, he does not, however, appear to have developed this equation to any great extent.

These give the acceleration of one molecule in terms of the forces due to all the others. The resultant force may be regarded as due to two actions: first, that of the remaining $h - 1$ particles of the group, and secondly, that of all the rest. As the configuration of the h particles is known, the averaging of the force must be performed only over the other; this is effected by integrating over all configurations of a single particle in an arbitrary position, supplied with the weight f_{h+1}/f_h. Hence $\overline{\eta^{(i)}}$ can be expressed in terms of an integral containing f_{h+1} in the integrand, and when this is substituted into (2) one obtains an integro-differential equation connecting two consecutive functions f_h and f_{h+1}.

The result is a chain of N integro-differential equations for the set of functions $f_1, f_2, \ldots, f_N$, which formulate the statistical laws of motion in a rigorous way. Each equation has the form (2), and contains one 'statistical term' involving, through $\overline{\eta^{(i)}}$, the following function f_{h+1}. The first task of a new theory is to show that it contains well-established special cases. We therefore require to prove that the Maxwell–Boltzmann kinetic theory of gases is a limiting case. This is effected by assuming the density to be so low that only binary encounters between the molecules need be taken into account, so that the function f_2 is, for large distances between the particles ($|x^{(2)}-x^{(1)}|$ large), a product $f_1(t, x^{(1)}, \xi^{(1)})$ $f_1(t, x^{(2)}, \xi^{(2)})$. Then the statistical term in (2) can, for $h = 1$, be transformed exactly into the 'collision integral' well known from the kinetic theory of gases, and the equation becomes identical with Boltzmann's integro-differential equation, from which all the thermo-mechanical properties of gases can be derived (*cf.* Chapman and Cowling[3]).

The second limiting case is that of equilibrium, where the new theory ought to be identical with statistical mechanics. It is easy to show that, if Gibbs's canonical distribution function is taken for f_N, and $f_{N-1}, f_{N-2}, \ldots, f_2, f_1$ are derived from it by integration, all our equations are satisfied. The proof rests essentially on the fact that no function f_{N+1} exists; hence the equation (2) has no statistical term for $h = N$. One can prove much more, however, namely, that under reasonable conditions, any configuration approaches the equilibrium distribution, so that the statistical motion is an irreversible process. The proof is very similar to the corresponding one in the kinetic theory of gases; it uses the notion of the H-function (negative entropy) defined in a way suggested by ordinary statistical mechanics. The validity of the H-theorem depends on a proper choice of the conditions under which the system is considered. If one assumes the system to be closed and completely independent of the outer world, no irreversibility can be expected. The last equation would then contain no statistical term, and as all of $f_{N-1}, f_{N-2}, \ldots, f_2, f_1$ can be expressed in terms of f_N, the solution would have no statistical character. One has to assume that the system of N particles is in thermal contact with a bigger one, which can be assumed to consist of the same kind of particles; this introduces in the Nth equation a statistical term containing f_{N+1}. Then the original system of N particles satisfies the H-theorem. In this way the new theory proves to be completely self-contained; it does not rely on results known from statistical mechanics, but contains this theory as a special case.

Although one would scarcely expect new results in this special case of equilibrium, we have investigated it again with our new methods, and find that these lead to new approaches to the intractable integrals of statistical mechanics. Our main general result is that all thermodynamical properties of the system can be expressed in terms of the function n_2 alone, which expresses the probability of finding two particles at given positions $x^{(1)}$, $x^{(2)}$. In the equilibrium of fluids, it depends obviously only on their distance r, and is identical with the radial distribution function determined in experimental investigations on the scattering of X-rays by monatomic liquids. Moreover, all thermodynamical quantities can be expressed in terms of the Fourier transform of $n_2(r)$, which is directly given by the intensity distribution of the scattered X-rays. Hence the thermodynamics of a liquid are reduced to the knowledge of this experimental function. The rigorous theoretical treatment leads to the well-known formidable difficulties in evaluating the partition function of statistical mechanics; the new formulation, however, suggests a different approach, which, though only approximate, can be easily improved. As we have pointed out, the second distribution function, depending on two particles, is not a product of two functions, each depending on one of the two particles. For example, $n_2(x^{(1)}, x^{(2)})$ differs from the product of $n_1(x^{(1)})$ and $n_1(x^{(2)})$ (which in equilibrium are both constant and equal). In the same way, the equation

$$n_1{}^3\, n_3\,(x_1, x_2, x_3) = n_2\,(x^{(2)}, x^{(3)})\; n_2\,(x^{(3)}, x^{(1)})\, n_2\,(x^{(1)}, x^{(2)}) \tag{3}$$

will not hold exactly, but will be a much better approximation to the real situation than $n_2(x^{(1)}, x^{(2)}) = \text{const.}$ If this equation (3) is not sufficiently accurate, one can use it as a first approximation and then assume a similar expansion for n_4 in terms of n_3, and so on.

In fact, Kirkwood[4] has shown that (3) leads to reasonable results; so we have accepted it and called it the 'Kirkwood' approximation. With its help, f_3 can be eliminated from the statistical term in the second equation (2), which together with the first then forms a closed system for the determination of f_1 and f_2. They can easily be reduced to a single integral equation for $n_2\,(r)$; it is a generalization for arbitrary central forces of an equation already established and solved by Kirkwood for 'rigid spherical molecules'.

We have succeeded in solving our equation for the general case, and find that at low temperatures there exist solutions which indicate an almost periodic behaviour of n_2; we believe that these correspond to the solid state (lattice structure). A Russian physicist, Vlasov[5], has published some papers in which he tries to derive the existence of crystal lattices from a Maxwell–Boltzmann equation in which the mutual forces of the particles are introduced, but the statistical term completely neglected. Although it seems to us that this attempt was not entirely successful, we believe that Vlasov's idea will prove correct.

Other solutions of the integral equation for $n_2(r)$ which for large r tend to the constant $n_1{}^2$ correspond to the liquid state. They have the well-known features of the radial distribution function in liquids: a set of density maxima the amplitudes of which rapidly decrease with r.

The $n_2(r)$ thus found can be used to obtain expressions for the free energy, from which all thermodynamical quantities can be derived. For low densities (gas), the pressure can be expanded in a series of powers of the density

$$p = \sum_{k=1}^{\infty} \beta_k n_1{}^k, \tag{4}$$

where the coefficients, the so-called virial coefficients, are functions of the temperature. Mayer[6] has succeeded, by a rigorous combinatory method, in finding expressions for the β_k in terms of integrals involving the potential energy $\varphi(r)$; but only the first few of these 'cluster integrals' could be evaluated, even for simple force laws. Our method produces for the β_k simple definite integrals which are much more tractable. Mayer has shown that the power series (4) ceases to converge at a definite density for each temperature, which he has associated with the point of condensation. But neither his work nor that of others (Born and Fuchs[7], Kahn[8], etc.) has succeeded in elucidating the character of the singularity or penetrating beyond it into the liquid region. Kahn has given an expression for the analytic continuation of the power series (4) into the region beyond the circle of convergence, but has misinterpreted his results. He accepts the well-known p–v diagram in which an isotherm is usually drawn with a horizontal part (p = const.) connecting the branches which represent the vapour and the liquid, and he endeavours to show that Mayer's method leads rigorously to such a region p = const., representing the process of condensation. In fact, this graphical representation of condensation by a line has no significance; the correct formulation is, that for a certain domain of pressure and temperature, the equation of state has two solutions v_1, v_2, for the specific volume, corresponding to stable states in equilibrium, vapour and liquid. The expression for p found by Kahn which he considers to be constant is, in fact, a function of volume; his error is due to his assumption that all the virial coefficients β_k are constant, whereas they depend on the volume more and more as k approaches the number of molecules in the liquid. Kahn's expression for p is the equation of state for the liquid, though in a quite untractable form.

Our theory shows that the liquid differs from the gas by the existence of real roots of a certain transcendental equation, revealing at once the analytical character of Mayer's singularity as a branch point, and allowing the derivation of an explicit equation of state in terms of the complex root of the same transcendental equation. The formulæ obtained are quite manageable; a numerical discussion is in progress.

The main object of our investigation is, of course, the derivation of the thermo-mechanical equations of motion and a determination of the coefficients of viscosity, thermal conductivity, etc., in terms of the atomic interaction. A new feature of this theory is that one obtains not only the ordinary equations of hydrodynamics (including the equation of the flow of heat), but also generalized ones describing simultaneously the motion of groups of molecules. In these there appear the mean number densities n_1, n_2, ..., n_h, the corresponding mean velocity vectors, $u_1{}^{(i)}$ $u_2{}^{(i)}$, ..., $u_h{}^{(i)}$, and the mean kinetic energies or 'temperatures' $T_1{}^{(i)}$, $T_2{}^{(i)}$, ..., $T_h{}^{(i)}$. The latter concept is of particular interest. These molar equations are solvability conditions of a kind for the integro-differential equations for the distribution functions f_h. The equations for f_h have a great many solutions which have no significance for our purpose (describing, for example, such configurations, where one particle is shot through the rest with an exceedingly high velocity, as may happen in radioactive processes). We have, therefore, singled out for study those 'normal' solutions, corresponding to ordinary hydrodynamics, where the state of the system is completely determined by the values of n_1, u_1 and T_1 for one particle, throughout the fluid. It appeared that the classical method developed by Hilbert[9], Enskog[10], and Chapman[11] in the kinetic theory of gases (virtually equivalent to an expansion in inverse powers of the mean free path) was useless for liquids, because there the free path becomes vanishingly short, and the mutual exchange of potential energy between the molecules correspondingly large. We therefore developed a new method of expansion in powers of the space gradients of the density, mean velocity, and temperature.

The result is, that all properties of a liquid in motion are, just as in the case of equilibrium, compounded of two parts, due to the thermal motion and the intermolecular forces respectively. The first, which is the only one considered in the theory of gases, is quite insignificant in liquids; when it is neglected, one obtains the coefficients of viscosity and thermal conduction as integrals involving the radial distribution function and its distortion by the motion.

The actual determination of this distortion is rather complicated, but one can obtain practical results without actually solving the appropriate integral equation. For it is evident that n_2 will have the form $n_2{}^0(1+\alpha)$, where $n_2{}^0$ is the equilibrium function, and α a correction due to the motion; the dependence of α on temperature and density can be determined by a simple dimensional consideration. The resulting integral can be evaluated by the method of steepest descent, as soon as the potential energy $\varphi(r)$ between two molecules is known. To give a concrete example, let us choose a function of the kind proposed by Lennard-Jones[12], $\varphi(r) = -ar^{-6} + b/r^{-12}$, the first term corresponding to the van der Waals attraction in the form obtained by London[13]. Then one obtains for the coefficient of viscosity

$$\mu = c\left(\frac{r_0}{r_1}\right)^5 \frac{m\nu_0}{r_0} \exp - \varphi(r_1)/kT. \tag{5}$$

Here c is a numerical constant, r_0 the equilibrium distance of two particles (diatomic molecule), given by $\varphi'(r_0)=0$, r_1 the actual mean distance of neighbouring particles, and $\nu_0 = \{\varphi''(r_0)/4\pi^2 m\}^{\frac{1}{2}}$ the frequency for the diatomic molecule.

One may compare (5) with the empirical formulæ of the type mentioned by de Guzman[14], and first established and studied in detail by Andrade[15]. At the melting point, Andrade's formula reads $\mu \sim \frac{m\nu_1}{r_1}$, where ν_1 is the frequency determining the specific heat, which may be taken, for example, from *Reststrahlen* results or put in terms of Lindemann's formula. One recognizes this factor in our formula (5), but with constant r_0 and ν_0 referring to the diatomic molecule. However, our formula depends on the volume in a different way from Andrade's, namely, by the factor

$$\left(\frac{r_0}{r_1}\right)^5 = \left(\frac{v_0}{v_1}\right)^{5/3}.$$

In fact, Andrade's ingenious derivation is based on a simplified physical picture which by its nature must fail to give dimensionless factors $\left(\text{powers of } \frac{v_0}{v_1}\right)$. Also Andrade finds the exponential factor, but gives no theoretical explanation except that it must be a kind of activation and, therefore, have the form of a Boltzmann factor.

A different formula for the coefficient of viscosity has been given by Fürth[16]. It is based on his theory of 'holes'; the liquid is regarded as a continuum of small bubbles, the size and apparent mass of which depend on the surface tension. These bubbles perform a kind of Brownian movement, and transfer energy and momentum; the coefficient of viscosity can thereby be expressed in terms of the surface tension. Fürth's formula contains an exponential factor of the same type as ours; the remaining factor cannot be compared with ours because of the entirely different assumptions made. But Fürth has shown that his formula is practically identical with Andrade's because of some empirical relations between the constants involved; and similar considerations can be applied by comparing Fürth's formula, or that of Ewell and Eyring[17], with our own.

Our theory also provides an account of the variation of the apparent viscosity of liquids under the action of external forces, such as electric and magnetic fields. One general conclusion here is that the field cannot by itself produce any change in the apparent viscosity if it can be derived from a scalar potential; this appears to be in accord with the recently published experimental work of Andrade and Dodd[18]. On the subject of conducting liquids and the effect of alternating fields, which they have also studied, we have not yet reached any definite conclusion; this remains a subject for further study.

We hope to generalize the theory also in the following different directions. The first and most obvious step is the introduction of internal degrees of freedom of the molecules; this is probably closely connected with giving up the assumption of central forces. Then mixtures of two or more kinds of molecules have to be considered in order to obtain the laws of ordinary and thermal diffusion; the latter (Soret effect) will be of special interest, as no theory for liquids seems to exist (see the dissertation by de Groot[19], Chap. 5). Also our theory gives, as we have mentioned before, clear indications of the appearance of the solid state; we hope that it will lead to a better understanding of the present lattice dynamics and its limits, in particular to theories of melting and plasticity.

The most important generalization envisaged is the introduction of quantum mechanics. For there are known several examples of quantum 'liquids': helium II (superfluidity), the substance of nuclei (droplet model), and perhaps also electrons in metals (superconductivity). It is, of course, hopeless to try to understand the abnormal viscosity in liquid helium if one has no theory of viscosity in normal liquids; this gap has now been closed, and we plan to extend our theory of viscosity to quantum liquids.

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ORIGIN OF ERYTHROCYTES

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CONVENTIONAL views on hæmopoiesis may be said to be well founded, in spite of the fact that beliefs in the transformation of precursor elements to definitive blood cells, through a series of specific cell stages, represent, so far as the adult mammal is concerned, dynamic concepts based upon more or less discontinuous observations—in the sense that no one has observed, either *in vitro* or otherwise, the whole process of transformation in adult tissue. Because of this it is not surprising that the facts have been interpreted differently at different times, and that more than one view has been advanced about the development of the blood elements. Equally, it is not surprising that commonly expressed views fail to account for all the known facts. The observations that are reported in this note fall so far outside current generalizations that they seem to lend themselves to a complementary hypothesis of blood formation.

If striated mammalian muscle that has been subjected to trauma is immediately fixed, cytological examination sometimes reveals the presence of very numerous cell elements that appear to constitute a continuous series of transition forms between muscle cells and granulocytes (in the rat, eosinophils in particular). As this observation could be taken to imply that muscle cells were being immediately transformed into leucocytes, as has been described by v. Möllendorff[1] and his school[2] in the case of fibroblasts, a series of experiments was undertaken, in which muscle was first excised and the injury inflicted *ex situ*, in a place chosen arbitrarily. These appear to show that extensive leucocytosis, accompanied by great numbers of transition forms, may occur in a muscle after its removal from the body. The circumstances obviously exclude the possibility of migration of leucocytes from the blood vessels, and also appear to preclude their origin from connective tissue cells, since cytological study of what seem the earliest transition forms suggests much more their derivation from muscle cells. The breakdown of the cellular muscular network results in the appearance of free cellular elements; and nuclear secretion appears to be the main factor responsible for the production of leucocyte granules. The process is so rapid that it has more the character of a cell-catastrophe than that of a slow transformation. The possibility of such a change is implied in Maximow's[3] final paper, where it is stated that, in areolar tissue, the transition forms ('Lochkerne') appear only very rarely in specimens in which the possibility of injury during preparation has been minimized so far as possible. This observation obviously implies that rougher treatment stimulates their instantaneous appearance.

Intense secretory activity is not confined to the muscle nuclei of injured muscle. It is a constant finding in a working and anoxic muscle, although in this case it leads not to the production of granules, but to significant changes in the muscle-columns adjacent to the active nuclei. Thus whereas in the resting muscle the sarcomeres are neatly levelled, in activated muscle-columns the nonius-periods appear, and this in places results in a complete release of sarcomeres. This process is always accompanied by

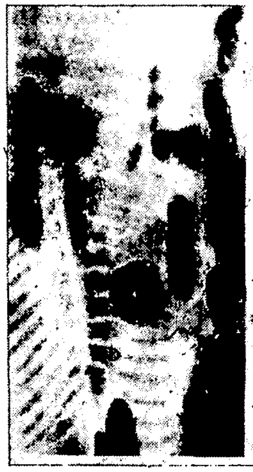

FIG. 1. WORKING MUSCLE (RAT). RELEASE OF SARCOMERES; THOSE LOWER DOWN HAVE THE APPEARANCE OF ERYTHROCYTES

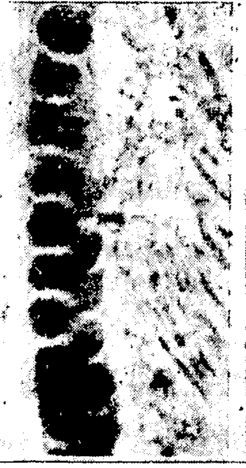

FIG. 2. ISCHÆMIA OF SHORT DURATION (RABBIT). APPARENT ABORTIVE ERYTHROPOIESIS RESULTING FROM THE TRANSFORMATION OF TWO MUSCLE-COLUMNS

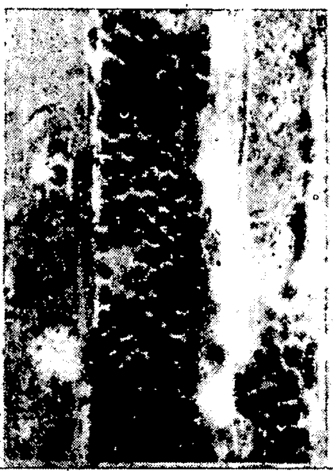

FIG. 3. MUSCLE DEGENERATION AFTER 5 DAYS (INJURY: FREEZING). APPARENT TRANSFORMATION OF THE WHOLE MUSCLE FIBRE

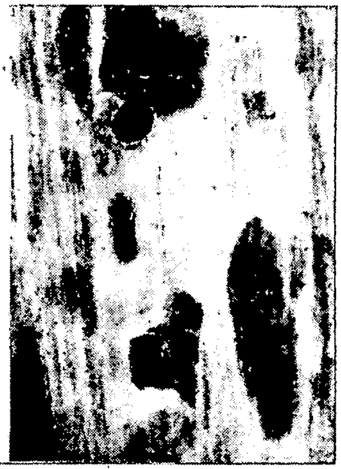

FIG. 4. WORKING MUSCLE (FROG). ABOVE: APPARENT ORIGIN OF FIVE THROMBOCYTES. BELOW: BUDDING OFF OF AN ERYTHROCYTE NUCLEUS

a striking change in the staining reaction of the sarcomere (best followed in Mallory stained sections), and by a marked increase of their refraction index (Fig. 1). The *A* disks of these sarcomeres, even before release, have a brilliant orange (eosin) or red (Mallory) coloration, contrasting with the pale colour of the alternating *I* disks. These observations can be related to the early findings of Bowman[4] (Bowman's disks) and to those of Thoma[5], who found that in certain conditions "the discoidal disintegration begins suddenly in an almost explosive manner". Reconstruction-models reproduced by Aurell and Wohlfart[6] provide useful information about the disposition of sarcomeres in the striated muscle, and the varying appearances which can be observed (nonius-periods, helicoidal fibres, staircase effect, sphenodes) would seem to constitute different stages in a process of sarcomere release.

The release and transformation of sarcomeres appear to be even more conspicuous in those forms of degeneration of striated muscle which are accompanied by hæmorrhage. The injury causing degeneration brings about a breakdown of the cellular network and a marked slowing down of the secretory process, while the nuclear secretion spreads more diffusely, and is not confined to discrete muscle-columns. As a result, a massive but abortive and stationary transformation appears to occur. In such cases (Figs. 2 and 3) the more or less freed sarcomeres are indistinguishable from erythrocytes. At the same time, isolated and secreting muscle cells appear to undergo an immediate transformation into lymphocytes. Rous[7] has shown that the number of lymphocytes delivered through the thoracic duct is increased fourfold as a prompt result of muscular activity. He concluded that "the variations caused by muscular exertion . . . are so pronounced as to suggest that the total number of lymphocytes in circulation must be considerably influenced by them. Clinical findings of other observers indicate that this is true. . . ."

All these cytological observations seem to call for a different, or at least an additional, approach to the problem of mammalian hæmopoiesis. Although it is recognized that in the early embryo red blood cells differentiate from primitive mesenchyme, their formation in later stages and in the mammal after birth is assumed to follow a series of fixed stages in their derivation from a nucleated cell in the red marrow. The basis of this genealogy is admittedly incomplete, and in part derives from a study of frank pathological conditions. One of its major difficulties is to explain the fate of the nucleus of the normoblast, in spite of the fact that its lysis (or extrusion) should be an extremely common occurrence.

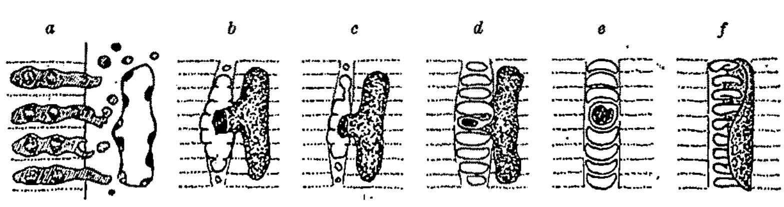

FIG. 5. COMPARATIVE ANATOMY OF ERYTHROPOIESIS (TENTATIVE SCHEME)

a Insects (redrawn from Holmgren[14]): trophospongial connexions between the muscle nucleus and sarcosomes.
b Frog: erythropoiesis (from observation *in vivo*); cf. Fig. 4.
c Frog: thrombocytopoiesis (from observation *in vivo*).
d Batrachoseps, tentative drawing based on figures given by Emmel[11].
e Mammal: lymphocytic hæmal unit \ homologous to the amphibian erythrocyte (from
f Mammal: endothelial hæmal unit / photomicrographs).

Nevertheless, without prejudice to this conventional hypothesis, on which they do not touch directly, the observations that are summarized in this note suggest that there may be another source of red cells in the body—striated muscle. They seem to indicate, first, that mammalian red blood elements may be 'cell products (plastids) non-homologous with cells', as was suggested more than fifty years ago on completely different grounds by Minot[8], and second, that striated muscle, owing to its high and immediate requirements of oxygen, is a store of partly preformed 'erythroplasts', and that it constitutes an erythropoietic organ of the normal mammal. As the muscle cells involved in the process assume, as a rule, the role of capillary endothelium, on our hypothesis erythropoiesis in these conditions is always intravascular: the 'opening up' of the muscular capillaries proceeds *pari passu* with the production of erythroplasts in their lumina—that is to say, muscle-columns may become transformed into blood-cell-bearing capillaries. By way of contrast, the question whether erythropoiesis is extravascular or intravascular remains controversial in the framework of current theories.

The likelihood that leucocytes and histiocytes can also be derived from muscle cells can be related to the analogous transformations of fibroblasts, as described by v. Möllendorff *et al.*[1,2]. On the hypothesis advanced here, striated muscle differs from mesenchyme by its immediate erythropoietic capacity. In this connexion it should be noted that Chèvremont[9] has recently conclusively shown that embryonic muscle cells in tissue culture may become transformed into histiocytes.

On the basis of our own evidence, as well as on that of other workers, the production of leucocytes may be regarded as a by-product of erythropoietic and vasoformative activity. In the frame of the working hypothesis put forward here, leucocytes can be regarded as the cellular waste, in the strictly morphological sense, of these processes, resulting from a partial or abortive response to the erythropoietic stimulus (probably anoxia) of some muscular elements.

The steps in this cytologically based hypothesis are set out in Tables 1 and 2.

Table 2 includes a reference to the 'vasoformative cells' of Schafer[10] and Ranvier[11], who remarked on the intracellular formation of red plastids as early as 1873 and 1874 respectively. It is also suggested that a single mesenchyme cell, be it a fibroblast or a myoblast, responds to anoxia in one particular way only, and that the end-forms into which they are transformed do not change one into another. Further, it follows that the process of inflammation may be regarded as the erythropoietic and vasoformative effort, more or less successful, of anoxic tissue.

TABLE 1. HÆMOPOIESIS IN MUSCLE. POSSIBLE NORMAL COURSE OF EVENTS. CELLULAR NETWORK REMAINS CONTINUOUS. ERYTHROPOIESIS STRICTLY INTRAVASCULAR AND ADEQUATE. NO TISSUE ANOXIA DURING VASOFORMATIVE ACTIVITY. SCANTY CELLULAR WASTE IS QUICKLY REMOVED

Erythropoiesis		Vessel formation	Removal of waste	
Demands: limited	high	↓ ↓ ↓	Scanty waste deposited:	
Rapid production	Massive production		extra-vascular in:	intra-vascular in:
Endothelial cell	Lymphocyte	The accompanying waste furnishes the normal amount of white cells	Lymph nodes	During development: thymus; later: spleen (liver), *bone marrow*
↓ Erythroplasts	↓			

TABLE 2. HÆMOPOIESIS IN MUSCLE. INFLAMMATION. THE BREAKDOWN OF CELLULAR NETWORK. ERYTHROPOIESIS PARTLY EXTRAVASCULAR ('DIAPEDESIS') AND INADEQUATE, OFTEN MASSIVE BUT ABORTIVE (STASIS, THROMBOSIS). TISSUE ANOXIA ELICITS PARTIAL RESPONSE OF THE VESSEL-BUILDING CELLS (GRANULOPOIESIS, LATER HISTIOPOIESIS). CELLULAR WASTE INCREASED AND NOT REMOVED (SUPPURATION, NECROSIS)

Erythropoiesis				Vasoformative effort					No removal of waste			
Full and quick response	Full and massive response	Full but unsuccessful response of isolated elements	Full and successful response interrupted by tissue damage	Quick partial response	Quick abortive response	Slower partial response	Delayed erythropoietic response of isolated elements	Slow response	Vestigial formative activity	Slow negligible response	Vestigial erythropoietic response	Delayed and vestigial or no response
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Endothelial cell + erythroplasts	'Lymphocyte + erythroplasts	Normoblasts	'Vasoformative cells'	Eosinophils	Polymorphonuclears	Basophils (mast cells)	'Erythrophages', Russell body cells, blood-pigment cells	Histiocytes	Epithelioid and giant cells	Polyblasts	Plasma cells, round cells	Myeloid elements
						Inflammation						
			acute					chronic				

A further study of surviving, as well as fixed and stained, frog muscle has shown that the nuclei of erythrocytes bud off from the muscle nuclei (Fig. 4), and suggest that the erythrocyte nuclei incorporate a number (6–8 ?) of sarcomeres into their cell body. This seems to explain the findings of Emmel[12] and others on the non-nucleated 'erythroplastids' of *Batrachoseps attenuatus* Esch., as well as the presence of bundles of myofibrils in amphibian erythrocytes, as has been recorded by Meves[13] and also by other workers.

Fig. 5 presents a scheme of a tentative comparison of erythropoiesis in vertebrates, and includes the phenomena described in the muscle of insects by Holmgren[14].

I wish to thank Prof. S. Zuckerman for advice and criticism in the presentation of this new working hypothesis.

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BRITISH COMMONWEALTH SCIENTIFIC CO-OPERATION

THE Report of Proceedings of the British Commonwealth Scientific Official Conference, London, 1946*, in addition to the Recommendations and Resolutions of the Conference, includes the opening statements of the Lord President of the Council and of the chairman of the Conference, Sir Edward Appleton, as well as a brief historical review showing the sequence of the Conference to that held in 1936, and its relation to the Royal Society Empire Scientific Conference which immediately preceded the Official Conference, and the recommendations from which are appended to this report. The Official Conference, which met during July 9–19, had as its terms of reference "to consider the best means of ensuring the fullest possible collaboration between civil Government scientific organisations of the Commonwealth and to make formal recommendations for the approval of the Governments represented". Defence science was not considered, and the working of the Imperial Agricultural Bureaux was reviewed at a further conference during the following week. Arrangements for the Conference were entrusted in October 1945 to a Working Party of the Civil Science Panel under the chairmanship of Mr. O. F. Brown, while on the arrival of the delegates in London, the heads of oversea delegations, together with the secretaries of the Department of Scientific and Industrial Research, the Agricultural Research Council and the Medical Research Council and a representative of the Colonial Office, formed a steering committee with Sir Edward Appleton as chairman and Mr. O. F. Brown as secretary.

In his opening statement, Mr. Herbert Morrison, emphasizing that it was possible to pay too much attention to organisation, pointed out that throughout the British Commonwealth we shall be faced for some years to come with an acute shortage of scientific man-power. Accordingly, there is a risk that too elaborate organisation might result in absorbing into the administrative machine many trained scientific workers who are badly needed in research laboratories, in universities or similar institutions, in Government laboratories or in industry. Sir Edward Appleton, also referring to the importance of a proper balance between university research and research under Government auspices, said that in Great Britain we have tried to avoid the danger of static Government research institutions by budding off new establishments from existing ones as need arose. He recognized the importance of active attention to the maintenance of the scientific health and outlook of workers in the Civil Service. University conditions generally ensure the maintenance of the mental adventurousness and lively imagination so necessary for scientific progress, and Sir Edward Appleton stated that an Interdepartmental Scientific Panel, of which he is chairman, is now considering the implementation of the recommendations of the Barlow Report on scientific staff. He urged that official scientific workers should do all that they can, when necessary, to convince their Governments of the importance of the Royal Society's Scientific Conference proposals for extending facilities for independent fundamental research at universities throughout the Commonwealth, and he pointed out that the pension provision of the civil 'scientific officer' grades in the United Kingdom scientific service is in most Departments specially designed to facilitate the movement of workers. The Department of Scientific and Industrial Research in particular favours such transfers as encouraging both fundamental research at the universities and applied research in industry.

One session of the Conference was in fact devoted to the movement of scientific men. The subject was discussed under four heads: the general need for interchange; student interchange within the Commonwealth; interchange of scientific staffs within the Commonwealth; and movement of scientific workers to assist territories outside the Commonwealth. Resolutions were passed urging steps to promote the maximum general interchange and supporting the Royal Society's Conference recommendation for the central compilation, classification and publication of lists of post-graduate scholarships available for scientific study within the Commonwealth, a task which would be appropriate to the proposed British Commonwealth Scientific Office, and favouring the provision of further travelling fellowships for post-graduate work, in particular the establishment of research fellowships tenable by United Kingdom students in the Dominions and in India. Other recommendations urge the exploration by university authorities of the possibility of co-operation in the award of post-graduate degrees; the exemption from income tax of all travelling scholarships and travel grants, and adoption of a system of adequate financial provision for travelling and subsistence allowances to avoid undue financial burden on the individual in travelling abroad for the purposes of study; special concessions for scientific workers travelling abroad for study, for attendance at scientific conferences and for similar purposes. The recommendations of the Royal Society's Conference that staff complements should be raised to a level sufficient to offer individuals adequate time for research, for study, and for travel leave without, thereby, placing additional burdens on their colleagues, are supported. Standard conditions are suggested for the temporary transfer of scientific workers, and the report of a committee set up by the Conference to consider superannuation was adopted. This report recommends the adoption throughout the Conference of a scheme or schemes with superannuation benefits not less favourable than those of the Federated Superannuation System for Universities. This session also noted the increasing demands from territories outside the Commonwealth for expert scientific advice, and suggested that such requests should pass through a British Commonwealth Scientific Office, London, so that the resources of scientific man-power and of educational establishments in other parts of the Commonwealth as well as of the United Kingdom may be used to the best advantage.

The first session of the Conference was concerned with the question of scientific liaison offices in view of its bearing on many of the other problems before the Conference. Sir Edward Appleton referred to the success of the appointment of scientific liaison officers during the War, and the first resolution of the Conference endorsed the views expressed in a resolution from the Royal Society's Conference on the functions of liaison offices as an essential part of the machinery for facilitating interchange of scientific workers and related activities. The Conference warmly welcomed the proposals for setting up a liaison office in London in which the several scientific liaison offices of the various parts of the Commonwealth would be housed under one roof, and certain common services such as library and records, typewriting, photographic services, microfilming, and photostating would be pooled, and invited the Governments concerned to proceed with the necessary arrangements as soon as possible. The Conference also regarded the British Commonwealth Scientific Office in Washington as a valuable and necessary element in the permanent machinery for scientific liaison, but recommended a change of name to "British Commonwealth Scientific Office, North America". A committee set up by the Conference, under Dr. E. Marsden as chairman, formulated detailed proposals regarding accommodation and common services, administration and finance for the London and Washington Offices to be subject to review in three years time, which were later adopted by the Conference.

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* British Commonwealth Scientific Official Conference, London, 1946. Report of Proceedings. Pp. 73. (London: H.M. Stationery Office, 1946.) 1s. 3*d*. net.

The next session, considering collaborative research and specialist conferences, at which Sir David Rivett presided, adopted a resolution recognizing the need for a standing committee which would be responsible for the arrangements for specialist conferences, in co-operation with appropriate Commonwealth or international bodies. It was recognized that, whereas there are subjects in which the work can be left to develop along its own lines, the workers merely requiring to be aware of what is going on in their fields in other parts of the Commonwealth, to be able to exchange information quickly and to be acquainted with progress in the development of new techniques and results, in other subjects a concerted attack is necessary. At its opening session the Conference had appointed committees on the agricultural sciences, medical sciences, and oceanography and fisheries to consider questions of collaborative research, and to these committees this session now referred a number of recommendations from the Royal Society's Conference.

To the Medical Science's Committee there were thus referred the recommendations on the physiological and psychological factors affecting human life under tropical conditions and in industry; the etiology and control of infectious and transmissible diseases; and on measures for dealing with the special nutritional problems of the British Empire, including the nutritional status of the indigenous peoples of the Colonies. In addition, the Conference referred to this Committee two recommendations: (1) that the attention of Governments of the Commonwealth in countries where malaria is prevalent should be directed to the urgent need of integrating fish-culture practice with measures for malaria control; and (2) that in view of the steady increase in the demand for insulin, all countries of the Commonwealth should make every effort to collect, process and preserve all available pancreas. The report of this Committee, which was adopted by the Conference, recommended that in each Dominion there should be a body sponsored by the Government and responsible for stimulating, supporting and organising medical research, and that each Dominion organisation should establish an effective liaison with the others so as to provide machinery for the discussion on strategy of research on problems of wide mutual interest, for calling specialist conferences when required, and for the movement of scientific workers between different parts of the Commonwealth. In endorsing the recommendations referred to it, this Committee urged the necessity for developing at all levels of Dominion and Colonial government a proper awareness of the nutritional needs of the indigenous peoples and also the need for more food technologists.

The Agricultural Sciences Committee recommended that the standing committee should examine the feasibility of calling at an early date a joint conference of specialists to explore the problems concerned with the integration of the three main branches of agricultural science. Of the subjects of the specific recommendations of the Royal Society's Conference referred to the Committee, soil conservation and land utilization, the maintenance of soil fertility with special reference to the role of soil organic matter, soil deficiencies in relation to plant and animal nutrition, the ecology of plants and animals of agricultural importance, and grassland and pasture research were suggested as suitable for discussion at such a conference. The control of vegetation by chemical means, insecticides and fungicides, pests in stored products, methods of collection and statistical analysis of data relating to agriculture, and biological control of insects and weeds are subjects recommended for inclusion in future specialist conferences.

The Committee was greatly impressed by the need for securing more adequate meteorological data as a basis for climatic studies, and the subject was considered by a sub-committee, which recommended the establishment at representative centres of meteorological stations equipped to measure the factors of moisture, light and temperature affecting biological activity; and indicated specific needs to be met. The equipment of biological field research stations was also recommended. The full Committee also recommended that the attention of Governments be directed to the need for preliminary surveys of the extent of utilization and of wastage of agricultural products in their individual territories as a basis for research, and to the importance of preserving native breeds of farm stock to serve as a source of breeding material, and of defining the structural and functional characteristics of such breeds. Further subjects recommended for reference to other committees or conferences included the provision of improved facilities for collecting living plant materials and for maintaining varietal collections of economic species; the extension of taxonomic and other biological research at museums and botanic gardens; and the utilization of aerial survey methods for studying and estimating crop areas and for detecting locust swarms. Various problems of plant physiology, genetics and pathology, and of the physiology of domesticated animals, suggested by the Royal Society's Conference for further research, were recommended for bringing before the notice of the appropriate government and university authorities.

The Oceanography and Fisheries Committee endorsed the various recommendations of the Royal Society's Conference referred to it and recommended particular attention to long-term research, in which regional co-operation should be an aim. The establishment of wave-recording stations to permit collaborative investigations of sea and swell conditions was also recommended, and the Committee stressed the need for the dissemination of information on oceanography, limnology, fisheries research and technology, especially to isolated research workers. The establishment of a journal for Colonial fisheries and oceanography would be welcomed.

Other committees were set up to consider radio and cosmic ray research; the establishment of a Commonwealth collection of type cultures; mineral resources and geology; building research; fuel research; food preservation; and regional research in Africa. Reports with recommendations from all these committees, which are detailed in the report, were considered at the 'review sessions', and the Conference also endorsed the recommendations of the Royal Society's Conference on modern methods of mapping and exploration by air.

Discussion at the session of the Conference devoted to aspects of collaboration in research between Government and industry centred mainly around the question of research associations. Concerning the publication of results, it was emphasized that practically all results of scientific work are published as papers before societies or printed in scientific periodicals. The Conference adopted a resolution noting with satisfaction the growth of the research association movement within the Commonwealth, and recommending no departure from the present practice whereby Government departments, research institutions or firms in Commonwealth countries, wishing to participate in the benefits of membership in a particular research association in another Commonwealth country, negotiate on a mutually satisfactory basis for membership with the Association concerned.

At the session on information services, the Conference adopted a resolution endorsing the general recommendation of the Royal Society's Conference regarding a conference on abstracting and information services, but recording the view that such a discussion should be regarded as preliminary to a wider conference to which the United States, as well as operating agencies of the United Nations concerned with the subject, should be invited. It was also recommended that the suggested British Commonwealth Scientific Office in London should organise machinery for ensuring that there is within each co-operating country a list of translations of scientific papers, made or contemplated throughout the Commonwealth, in languages other than English. A committee appointed to consider proposals for alteration in the organisation and functions of the Imperial Institute recommended the adoption, in general, of the suggestions of the Skelton Committee of the Imperial Committee on Economic Consultation and Co-operation, 1933, but suggested the establishment of two separate organisations for dealing with mineral resources and with plant and animal products respectively.

The session dealing with the utilization of the results of research adopted three resolutions. First, as regards information on methods for promoting the utilization of non-patentable scientific and technical results which have been found successful, the Conference desires the appointment of an editor, attached to the British Commonwealth Scientific Office in London, to collect this information and prepare a report for circulation by December 1947. The second resolution recommends the establishment of close co-operation between any organisations established locally to ensure the maximum utilization in the national interest of patentable discoveries, in order that there may be the greatest possible use of patentable discoveries throughout the Commonwealth and Empire. Finally, it was agreed that a practical scheme for a Commonwealth patent would have substantial advantages for technical development in the Commonwealth, but it was realized that technical difficulties may well render such a scheme impracticable; the Conference, therefore, recommended that heads of delegations should discuss with their Governments the desirability of re-examining the whole question.

At the final review session, the Conference adopted resolutions to provide permanent machinery for facilitating scientific collaboration in the Commonwealth and for following up the recommendations of the Conference by establishing a standing committee, with a secretary and 'working party' in London. The standing committee consists of the executive heads of Government organisations for scientific and industrial, agricultural and medical research in the United Kingdom, the Dominions and India, together with three scientific representatives nominated by the Colonial Office. The 'working party' consists of deputies of members of the standing committee with its secretary as chairman, and the overseas members of the standing committee have already indicated that their deputies will be their liaison officers serving in London.

OBITUARIES

Prof. Karl Mannheim

It is quite impossible to estimate the loss which education and scholarship have suffered as the result of the untimely death on January 9 of Karl Mannheim at the early age of fifty-three. Though we have had him with us in Britain for barely fourteen years, his work and influence among us afford a signal example of the gain that accrues to this country from the welcome which, by tradition, it gives to refugee thinkers and scholars. A Hungarian by birth, he held the chair of sociology at the University of Frankfurt when the Nazis came to power. A marked man, he was removed from his post and took refuge in Britain. Here the London School of Economics generously made a place for him.

Distinguished as he was as a sociologist, his deepest concern was for education. To it, guided by well-grounded principle and proceeding in conditions of spiritual and intellectual freedom, he looked as a main instrument for the reconstruction which he knew that Western culture would have to undergo. He spoke often of what he called the 'Middle Way' or the 'Third Way', the *via media* between *laisser-faire* and totalitarianism. It was his conviction that Britain had the mission of demonstrating to the world how that way could be marked out and followed.

Wholly sympathetic to the English spirit, and coming in the fullness of his powers to assimilate and share in it, Mannheim was able to note elements of strength and weakness which were likely to be less apparent to the native-born. It was that, more than anything else, which made his personal influence so immensely valuable. So he was at his best in a seminar, or particularly in a discussion group with intimate friends. Then one saw how the humility and the profound humanity of the man were the sources from which arose the quick understanding, the intuitive sympathy and the infinite teachableness which were so characteristic of him.

In his teaching as in his works ("Ideology and Utopia", "Man and Society in an Age of Reconstruction", and "Diagnosis of our Time"), he claimed to be attempting no more than diagnosis. What he had of prescription was still for him in the region of fundamental hope and faith, rather than in that of a worked-out programme. Perhaps the latter part of his "Man and Society" could be taken as his formulation of the problem of our time—planning for freedom. As a further contribution to the co-operative study of the crowding problems, he planned the series of monographs which have been appearing in the International Library of Sociology and Social Reconstruction. Under his general editorship, some forty volumes have already appeared, and others are in preparation or projected.

But great and far-reaching as Mannheim's work and influence as a sociologist have been, it is as a teacher that his memory will be most deeply treasured. Those who knew him and realized what he had to bring to British education could not but applaud when, towards the end of 1945, the University of London appointed him to the chair of education at the Institute of Education, where, for some years previously, he had given a lecture course. Students knew his value. "It was always an inspiration to us when he lectured" is a typical comment by one of them.

Irreparable as the loss is, we can yet take some comfort in the belief that his work among us had proceeded far enough to ensure that his influence will abide, and that what he taught us concerning our own mission and destiny will remain to guide us in those trials of the spirit through which we may still have to pass. F. C.

Prof. L. W. Lyde

THE death on January 24 at his home at Cirencester of Prof. Lionel William Lyde has removed from the active list another of the small band of pioneers who laid the foundations in Britain of the modern concept of geography, and its re-recognition as a subject of university status. Chisholm, Herbertson, Mackinder, H. R. Mill, Marion Newbigin and Lyde each contributed in a different way to this revival; each brought to bear upon the problems of the new sphere of interest a mind trained in other disciplines.

The son of Canon Lyde of Queens' College, Cambridge, Lyde was born on March 28, 1863, and educated at Sedbergh and Queen's College, Oxford, where he held a classical exhibition. Literary and classical studies were the background of his work, and it was his interest in classical history which led him to the study of man in relation to his environment. His first book, "An Introduction to Ancient History" (1890), published when he was English master at Merchiston School, Edinburgh, was followed by two school text-books, "Man on the Earth" (1895) and "Man and his Markets" (1896), which undoubtedly exercised an enormous influence on the school teaching of geography. Lyde was still a comparatively young man when his publishers gave a small dinner to mark the sale of the two millionth copy of his books.

After a period in Glasgow and as headmaster of Bolton Grammar School (1899–1903), he went to University College, London, as professor of geography—in the days when colleges could appoint professors at purely nominal salaries. For many years his students could only qualify for diplomas but, through the efforts of Lyde, H. N. Dickson, A. R. Hinks and others, London instituted an honours degree, and it was Lyde who trained the seven students who were the entrants to the first examination in 1921. He was an inspiring teacher and exercised a great influence over his students. He had marked likes and dislikes—of people, their work and ideas—and he had something of the historian's worship of contemporary sources, which led him to place undue reliance on local scraps of information culled from the most varied sources. "The Continent of Europe" (1913) and "The Continent of Asia" (1933) thus combine wide reading and deep scholarship with both sound and ill-founded deductions. His appreciation of Oriental, especially Chinese, scholarship influenced his own search for an underlying geographical philosophy, and "Peninsular Europe"—a difficult book to read—is an attempt to trace the influence of peninsularity on European history.

When he left University College in 1928, Lyde returned to his old love, the classics, and published a number of books. In all this work he had the sympathy and help of his wife and his two sons.

L. DUDLEY STAMP

NEWS and VIEWS

Prof. J. W. Heslop Harrison, F.R.S.

ON September 30, 1946, Prof. J. W. Heslop Harrison retired from the chair of botany in King's College, Newcastle upon Tyne. Since that date, the University of Durham has conferred upon him the title of professor emeritus, so giving due honour to one of her most illustrious north country sons. In 1917 he went to Newcastle, holding a research appointment as a senior investigator under the Department of Scientific and Industrial Research. Later, he became a lecturer in zoology, and in 1926 was elected to a college readership in genetics. In 1927 he was appointed to the chair of botany, when the late Prof. J. W. Bews returned to South Africa. His earliest researches were concerned with biogeography. In particular, they dealt with the flora of Upper Teesdale and Lepidoptera of a bifocal distribution. His genetical and cytogenetical researches commenced with studies in interspecific hybridity and heredity in the Lepidoptera, more especially in the sub-family Bistoninæ and the genus *Oporinia.* Observing the prevalence of melanism in this genus, he studied its incidence, causes and induction in many Geometrid genera. Cytogenetical examinations in the interspecific crosses gave rise to investigations on the relations between chromosomes and phylogeny in the Lepidoptera and thence to the detection of polyploid series in the group—a totally unexpected phenomenon. In considering the effects of natural selection in wild *Oporinia* populations, Prof. Harrison saw possibilities of Lamarckian explanations. Accordingly he planned and carried out experiments (*a*) on the development of inherited, new food habits in the sawflies of the genus *Pontania*, and (*b*) on the production and inheritance of light effects in the pupæ of the butterfly *Pieris napi*. Prof. Harrison's genetical work on plants began with field observations on wild roses and willows, which led to researches in the cytogenetics of *Rosa* and its hybrids as well as of *Salix*, and the discovery that most British roses are of hybrid origin. In 1934 he commenced his work on the flora and fauna of the Hebrides. From these studies in systematics proceeded intensive studies in the biogeography of the area and in its Pleistocene and Holocene history and geography.

We have been informed that Prof. Harrison hopes to devote much time in future years to research. At present he remains working at King's College, holding for two years a College Research Fellowship, giving lecture courses on genetics and evolution, and supervising postgraduate researches in genetics. We hope that this last phase of his University career will prove as fruitful as all the varied earlier ones have been, and that many happy years are in store for him when he finally withdraws from the walls of his proud and grateful Alma Mater.

Psychology at Aberdeen : Prof. Rex Knight

The most recent addition to the number of university chairs in psychology is at Aberdeen, where Mr. Rex Knight has been appointed to the Anderson professorship. Prof. Knight was born at Wilcannia, New South Wales, in 1903, and graduated from the University of Sydney in 1923 and the University of Cambridge in 1925. He was a member of the staff of the National Institute of Industrial Psychology during 1925–28, first as an investigator, then as assistant to the director, the late Dr. C. S. Myers, and co-editor of the Institute's journal. After a year as lecturer at the University of St. Andrews, he was appointed Anderson lecturer (later reader) in psychology at the University of Aberdeen in 1929. During the War, for three years he gave a weekly broadcast commentary for the Ministry of Information, together with numerous lectures for the Central Advisory Council for Education in the Forces in remote parts of Scotland. During 1943–45 he was attached to the War Office staff of the Directorate for Selection of Personnel. His book on "Intelligence and Intelligence Tests" is widely used, and he is well known for his advocacy, in 1932, of the strictly scientific approach to animal psychology (cf. his article in *Nature* of Nov. 9, 1932, on "The Explanation of Animal Behaviour"). But Prof. Knight's main interests are in dynamic and social psychology, the applications of psychology to everyday human problems, its relation to literature and the other arts, and the role of psychology as an ingredient in a general education.

University of Glasgow

The Department of Scientific and Industrial Research has offered to supply and erect for the Department of Natural Philosophy of the University of Glasgow a 300 MeV. synchrotron, and to make a capital grant of £3,500 towards the provision of a high-voltage generator. Dr. J. M. Hyslop has resigned his lecturership in mathematics in the University on his appointment to the chair of mathematics in the University of Witwatersrand. Dr. T. S. Stevens has resigned from the Department of Chemistry to become lecturer in organic chemistry in the University of Sheffield; Drs. Stanley Alstead and R. A. Shanks have resigned from the Department of Materia Medica to become (respectively) medical consultant for the North of Scotland at Inverness and medical registrar at Yorkhill Hospital for Children, Glasgow. Messrs. C. E. Bond, R. Lambert Hurt and A. J. Webster have been appointed assistants in the Department of Anatomy, and Mr. John Higginson an assistant in bacteriology.

Mechanical Recording of Information

The system used at the Royal Cancer Hospital to record information numerically about cancer patients so that it can be transferred to a punched card and sorted mechanically is described by D. W. Smithers, K. M. H. Branson and H. O. Hartley in a pamphlet which includes also the instruction book and code book in use (from the Royal Cancer Hospital). This information should be of general interest to the medical research worker and to others who are considering the use of punched cards for bibliographic purposes or statistical analysis. The essential features of the system are the compilation of a special record card from notes on the patient, the information on the card being such that it can be expressed in numerical form and is suitable for rapid analysis by mechanical means. Filling in this card is the only extra clerical work required of the medical man, usually a registrar, beyond his usual duties of keeping accurate notes. The time required for coding and preparing the card for punching is greater, but this work can be carried out by a specially trained clerk. The special record cards remain the property of the hospital and are filed there. Most of the information on these cards can be transferred to a Hollerith punched card by a clerk trained for the purpose and employed by the hospital, or if no such clerk is available they may be sent for punching to the British Tabulating Machine Co., Ltd. As analysis of both standard data and special hospital data is made mechanically, information obtained from the cards can be supplied either to a central organisation, an individual hospital or to any clinician concerned.

The Royal Cancer Hospital and the group of hospitals with which it co-operates are giving the system a preliminary trial for all cancer patients coming under their care from January 1, 1945.

Abstracts of World Medical Literature

Two new monthly medical abstracting journals, *Abstracts of World Medicine* and *Abstracts of World Surgery, Obstetrics and Gynæcology*, have been published by the British Medical Association. The first (January) issues have now appeared, and even a glance through the pages shows that Dr. Hugh Clegg, editor of the *British Medical Journal*, under whose general direction they are being issued, and Dr. G. M. Findlay, who edits them with the assistance of Dr. S. S. B. Gilder and a panel of advisers, are to be congratulated on both the planning and the execution of the considerable task which they have undertaken. The foreword to both these issues traces the history of recent medical abstracting work, from the Medical Research Council's publication during the First World War, of information derived from medical literature then appearing, to the similar service begun during the Second World War and continued in the form of the *Bulletin of War Medicine*. The success of the latter encouraged the British Medical Association to continue an abstracting service when this bulletin ceased publication in 1946, and the two new journals are the result. They give, over a remarkably wide range, abstracts of articles selected from more than a thousand periodicals. Comments by the abstractors are printed inside square brackets, so that there will be no confusion between the views of the abstractor and those of the authors of the article abstracted.

The type chosen for the new journals is attractive and clear, and they are so bound that they are pleasant and convenient to use. They form a valuable supplement to the excellent epitomes of British medical literature published in the *British Medical Bulletin*, which was born in 1940 in the editorial department of the British Medical Association as a medical information service to provide, in collaboration with the Ministry of Information, foreign medical journals with surveys of current British medical literature. Later, this service was taken over by the British Council and became, under the able editorship of Dr. Howard-Jones, the *British Medical Bulletin*, which is now an essential feature of medical literature. Medical men all over the world now have, therefore, an information service which should keep them well informed of every important development.

British Standard Specification for Cable Insulation

A 1946 edition of the well-known British Standard No. 7, the first edition of which appeared in 1904, and which deals with rubber-insulated cables and flexible cords for electric power and lighting, has recently been issued. The main specification, together with a supplement on the use of polyvinyl chloride compounds as an alternative to vulcanized rubber, is published as a single volume (B.S.7; 1946. British Standards Institution, Publications Department, 28 Victoria Street, London, S.W.1. 3*s.* 6*d.*, post paid) and an amendment, entitled "Transitory Relaxations", is issued separately in the form of a leaflet (Ref. *PD* 540). War-time conditions hastened the introduction of polyvinyl chloride insulated cables, and this necessitated several modifications to the original specification. The 1946 edition, while retaining in substance all the usual features, makes allowance for the change-over to peace-time conditions. Some of the modifications referred to above are retained as permanent revisions to the specification, others are retained only temporarily, to be dropped eventually, while others have been entirely cancelled. The specification is divided into three sections: the first, of a general nature, defining terms, sizes, etc., used later in the specification; the second, dealing with the construction of the different types of cables and cords; and the third, with tests for thickness of insulation and sheath, voltage, insulation resistance, spark testing, tinning and armouring. The numerous tables with which the specification is provided make the publication an extremely useful one for all users and manufacturers of electrical cables and cords.

Durban Museum and Art Gallery

Although the annual report of the Durban Museum and Art Gallery for the year ended July 31, 1945, shows their satisfactory maintenance as cultural and educational centres, it points out the need for extensions if these institutions are to function in a manner adequate to the future needs of a city growing in both size and importance. A new building has been embodied in a post-war development scheme, and it is now recommended that this be erected as soon as circumstances permit. Schools continued to make good use of the Museum services during the year. Eighty-nine gallery talks—many of which were augmented by lantern-slide or film shows—were delivered to visiting classes, and the showing of instructional films relating to subjects lying within the scope of the Museum was a regular weekly feature. An interesting departure from the usual type of film shown in museums was one demonstrating the activities of the Durban municipal departments.

History and Comparative Study of Religion

An effort is being made to establish in Cambridge a photographic record for use in illustrating the history and comparative study of religions. Any persons, especially those returning from the Services or from the mission field, who may have photographic prints of religious buildings or ceremonies (whether Christian or non-Christian), are invited to send spare copies for this collection. Any contributions will be filed and preserved, with the names of the donors duly recorded. Communications should be sent to the voluntary curator of the record, the Rev. Dr. Bouquet, Gilling House, Madingley Road, Cambridge. It is also desired to register the whereabouts of cinematograph films dealing with the same subjects, especially if in private hands.

Summer School in Social Biology (Switzerland)

The British Social Hygiene Council proposes holding a summer school on "Social Biology: its International Aspects", in Switzerland during the last fortnight in August. It is proposed to devote one week to study and the second week to visits, expeditions and recreation. The School is intended for teachers and social workers, and others interested in social biology from Britain, but it is hoped that there will also be students from other countries. Lectures will be in English. The estimated cost, including travel, board and tuition, will be between £25 and £30. Further information can be obtained from the Secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

Announcements

Mr. S. S. Carlisle, a graduate of Queen's University, Belfast, has been appointed head of the Instrument Section of the British Iron and Steel Research Association, in succession to Mr. W. C. Fahie, who is taking up an appointment in the Ministry of Defence. Mr. Carlisle joined the Association in October 1946, following four years' service in the Experimental Department, H.M.S. *Excellent*, Portsmouth, on the staff of the Director of Scientific Research, Admiralty, where he was largely responsible for the design and development of certain special recording instruments and electro-mechanical control systems associated with modern gunnery and radar techniques.

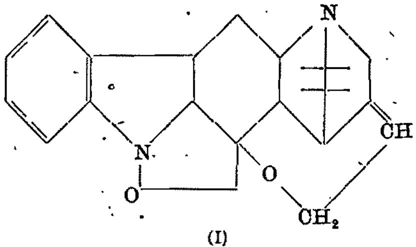
One of the activities of the Viking Fund (14 East 71st Street, New York) is the publication, in conjunction with its summer seminar in physical anthropology, of a "Yearbook of Physical Anthropology", which consists, in the main, of reproduction in full of a score of important papers appearing during the year. The yearbook is distributed free of charge to members of the American Association of Physical Anthropologists and to other interested persons. The second issue (for 1946) is now in preparation, and the editor, Dr. Gabriel Lasker, would welcome reprints and references to material which might be considered for inclusion.

LETTERS TO THE EDITORS

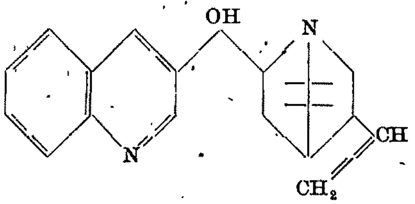
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Constitution of Strychnine and its Relation to Cinchonine

The progress of experimental studies of strychnine derivatives, especially of neostrychnine, in this Laboratory has shown that no formulation hitherto suggested is adequate. Furthermore, it has not been found possible to modify the structure in a satisfactory manner on the basis of generally accepted deductions in regard to the ring containing the amide group. The validity of the simple and direct explanations of Leuchs' degradation of the strychninolones and brucinolones has therefore become questionable, and feasible alternatives of a more complicated character have been devised. These allow the amide ring to be five-membered, and on this basis an entirely novel and very satisfactory strychnine constitution (I) can be developed. This serves to illustrate the whole chemistry of the alkaloids, including the most recent findings, and must therefore be regarded as the best working hypothesis at present available. It is free from all stereochemical difficulty, and double bonds can be accommodated where necessary.



(I)



Cinchonine

It can be set up on the models in strainless stereoisomeric forms, of which the two most characteristic are those obtained by *cis* and *trans* disposition of the nitrogen atoms in relation to the central *cyclo*hexane ring. The carbon skeleton can be dissected in exactly the same way as was indicated[1] in the case of another formula (with six-membered amide ring), but the relation with cinchonine is now even closer and is at once apparent on comparison of the structures. Speaking only of the carbon–nitrogen skeleton, (I) is cinchonine in which an indole nucleus replaces quinoline, and there are three additional carbon atoms in the amide ring. This is a very striking result, and nothing similar can be achieved by retaining a six-membered amide ring.

The cinchonine formula is depicted in an unusual arrangement to facilitate the comparison with (I).

A fuller discussion and description of relevant experiments will be submitted for publication elsewhere.

R. Robinson

Dyson Perrins Laboratory,
University of Oxford. Jan. 14.

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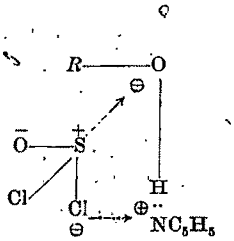
[1] Openshaw, H. T., and Robinson, R., *Nature*, 157, 438 (1946).

Influence of Tertiary Bases on the Interaction of Thionyl Chloride and Hydroxy Compounds

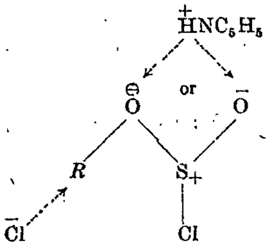
In contrast to the observations of Human and Mills[1] on the use of pyridine in the interaction of thionyl chloride and the carboxylic group, we found that instead of *one* molecular proportion of tertiary base in the Darzens' procedure[2] for hydroxy compounds, much less than 0·1 mol. of base or its hydrochloride was sufficient. Thionyl chloride (1·0 mol.) was added to a cooled mixture of the hydroxy compound (*iso*-amyl, *n*-butyl, β-phenylethyl alcohols, or ethyl lactate) (1·0 mol.), and a few drops of base (pyridine, quinoline, or dimethylaniline) or a small amount of the corresponding hydrochloride. An excellent yield of the chloride (*R*Cl) was distilled directly from the reaction mixture, after it had been heated for four hours at 65–80° (depending on the base). Yields approaching 95 per cent were obtained.

To account for the ease with which thionyl chloride forms pyridine hydrochloride and the sulphite (R_2SO_3), it was suggested by one of us[3] that the lone pair of electrons on the nitrogen atom forms a hydrogen bond with the hydroxylic hydrogen, and this facilitates properly orientated 'broadside' collisions (I). The function of the small amount of pyridine hydrochloride in facilitating the decomposition of the intermediate chlorosulphinate (*R*OSOCl) formed in the interaction of thionyl chloride and hydroxy compound may also be due to hydrogen bonding (II), the *R*—O bond being thereby sufficiently weakened to increase the probability of fruitful attack along the 'end-on' direction by such groups as Cl^- or OSOCl. The ion $C_5H_5NH^+$ is repeatedly regenerated. Certain structural features, such as a phenyl group attached to the reactive centre, may lead to deviations which can only be discussed in detail.



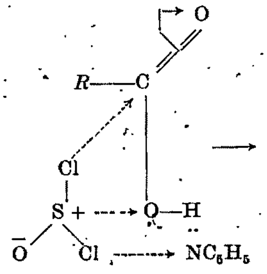
→ R_2SO_3
+ $2C_5H_5NHCl$

I



→ RCl + SO_2
+ C_5H_5NHCl

II



⟶ ROCOCl
SO_2
C_5H_5NHCl

III

Hydrogen bonding may account for the better results obtained by Human and Mills when they used pyridine in *one* molecular proportion in their experiments with carboxylic acids (III).

W. GERRARD
K. H. V. FRENCH

Northern Polytechnic,
Holloway Road,
London, N.7.
Jan. 13.

[1] Human and Mills, *Nature*, **158**, 877 (1946).

[2] Darzens, *C.R. Acad. Sci., Paris*, **152**, 1314, 1601 (1911).

[3] Gerrard, *J. Chem. Soc.*, 688 (1936); 99 (1939); 218 (1940); 85 (1944).

Absolute Values of the Rates of Unimolecular Reactions

EXPERIMENTAL unimolecular reaction-rates in gases are adequately represented by the equation:

$$K_{\text{uni}} \equiv -\frac{1}{N}\frac{dN}{dt} = a \exp(-E/kT)\ \text{sec.}^{-1}, \qquad (1)$$

where N is the concentration, T the absolute temperature, and k is Boltzmann's constant. The fact that a is in most cases found to be of the order of magnitude of intramolecular vibration frequencies (10^{14} sec.$^{-1}$) has been much discussed. By an approach akin to that of Polányi and Wigner[1], I obtained a theoretical reaction-rate in which a, although not precisely determined, was of this order of magnitude[2,3]. This result can now be made precise.

The gas molecule is treated (as before) as a classical system with n internal degrees of freedom, and n normal modes of harmonic vibration; the vibration frequencies $\nu_1, \ldots \nu_n$ of these modes are assumed to be linearly independent numbers. The time-variation of a geometrical co-ordinate q, such as the extension of an inter-atomic bond, is a sum of normal-mode terms:

$$q = \sum_{s=1}^{n} \alpha_s \sqrt{\varepsilon_s} \cos 2\pi (\nu_s t + \varphi_s), \qquad (2)$$

where ε_s is the energy and φ_s the phase-angle in the s th normal mode; on this classical picture, the ε_s and φ_s change only at molecular collisions. The 'amplitude factors' α_s are constants characteristic of the particular co-ordinate q considered.

The molecule is assumed to dissociate when one particular co-ordinate q attains a critical high value q_0. This value is attainable only after collision has raised the internal energy to satisfy

$$\Sigma \alpha_s \sqrt{\varepsilon_s} \geqq q_0, \qquad (3)$$

but the molecule dissociates only if the terms in (2) have time to come sufficiently into phase for q to reach q_0 before further collision removes the high energy. If then $L(\varepsilon_1, \ldots \varepsilon_n; q_0)$ is the frequency with which the sum (2) would attain q_0 if undisturbed, L may be taken to represent the proportion of molecules with energies ($\varepsilon_1, \ldots \varepsilon_n$) which dissociate per second.

At the high pressures at which de-energizing collisions are much more frequent than dissociations, the number of molecules with energies in the ranges ($\varepsilon_1, \varepsilon_1 + d\varepsilon_1$) . . . ($\varepsilon_n, \varepsilon_n + d\varepsilon_n$) is very nearly the equilibrium number, namely,

$$N(kT)^{-n} \exp(-\Sigma \varepsilon_s/kT) d\varepsilon_1 \ldots d\varepsilon_n.$$

A fraction L of these dissociate per second; thus the total dissociation-rate is the first-order rate:

$$K_{\text{uni}} \equiv -\frac{1}{N}\frac{dN}{dt} = \int_0^\infty \cdot \cdot \int_0^\infty L(\varepsilon_1, \ldots \varepsilon_n; q_0)$$
$$(kT)^{-n} \exp(-\Sigma \varepsilon_s/kT) d\varepsilon_1 \ldots d\varepsilon_n. \qquad (4)$$

(We can integrate from $\varepsilon_s = 0$, since $L = 0$ where (3) is not satisfied.)

Now

$$L = \tfrac{1}{2} \lim_{\tau \to \infty} \{M(\tau)/\tau\},$$

where $M(\tau)$ is the number of zeros, for $0 \leqq t < \tau$, of $q - q_0$ with q defined by (2). I used before[2] an approximate formula for this limit, but use now a formula due to Kac[4], which gives in our notation:

$$L(\varepsilon_1, \ldots \varepsilon_n; q_0) = \frac{1}{4\pi^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \frac{\cos(q_0 \xi)}{\eta^2} \Big\{ \prod_1^n J_0(\xi \alpha_s \sqrt{\varepsilon_s}) -$$
$$\prod_1^n J_0 [\alpha_s \sqrt{\varepsilon_s (\xi^2 + 4\pi^2 \nu_s^2 \eta^2)}] \Big\} d\xi d\eta. \qquad (5$$

Inserting this in (4) and integrating first for the ε_s by means of Weber's formula[5], we find that

$$K_{\text{uni}} \doteq \nu \exp(-q_0^2/\alpha^2 kT),$$

where

$$\alpha^2 = \Sigma \alpha_s^2, \quad \nu^2 = \alpha^{-2} \Sigma \alpha_s^2 \nu_s^2. \qquad (6)$$

It is easily found that the minimum total internal energy for dissociation, that is, the minimum $\Sigma \varepsilon_s$ satisfying (3), is

$$E_0 = q_0^2/\alpha^2.$$

Thus, finally,

$$K_{\text{uni}} = \nu \exp(-E_0/kT). \qquad (7)$$

The factor ν in this result is, by (6), the root mean square of the vibration frequencies weighted by the amplitude factors α_s. It is thus independent of temperature, so that[3] the energy E_0 in (7) may be identified with the empirical E of (1) as the 'activation energy'.

A full discussion of this theory, with an extension to low-pressure dissociation-rates, will be given elsewhere.

N. B. SLATER

Department of Mathematics,
University, Leeds.
Dec. 27.

[1] Polanyi and Wigner, *Z. phys. Chem.*, A, **139**, 439 (1928).

[2] Slater, *Proc. Camb. Phil. Soc.*, **35**, 56 (1939).

[3] Fowler and Guggenheim, "Statistical Thermodynamics", 529 (1939).

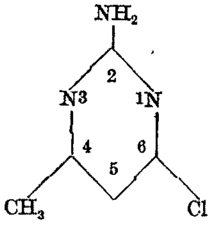
[4] Kac, *Amer. J. Math.*, **65**, 609 (1943).

[5] Watson, "Theory of Bessel Functions", 393 (1922).

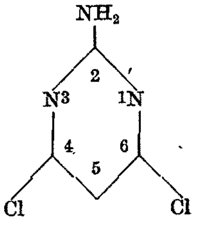
Crystal Structures of 2-Amino-4-Methyl-6-Chloropyrimidine and 2-Amino-4,6-Dichloropyrimidine

A SERIES of investigations on the structures of pyrimidines and purines is being carried out in close association with the work of Prof. A. R. Todd and his collaborators on the chemistry of these and related compounds.

No previous structural work on pyrimidines has been reported in the literature, so an extensive search was made for compounds which seemed likely to permit of a determination of structure without previous assumptions as to the nature of the pyrimidine molecule. Two isomorphous pyrimidines were selected: 2-amino-4-methyl-6-chloropyrimidine (I) and 2-amino-4,6-dichloropyrimidine (II).



(I)



(II)

Both compounds crystallize from alcohol as thin laths the lengths of which correspond to the *b*-axis. The monoclinic unit cell has dimensions, $a = 16 \cdot 4$, $b = 3 \cdot 8_5$, $c = 10 \cdot 3$ A., $\beta = 108°$, and the space-group is $P2_1/a$ (C^5_{2h}) with four molecules in the cell. The intensities of nearly 200 *hol* reflexions were determined from Weissenberg photographs of both compounds. These intensities were used in the computation of Patterson projections along the *b*-axis, and for the dichloro compound it was possible to determine x and z co-ordinates for both of the chlorine atoms. Phases could then be assigned to a number of the terms used in a Fourier synthesis which gave a first approximation to the structure. The third approximation is illustrated in Fig. 1.

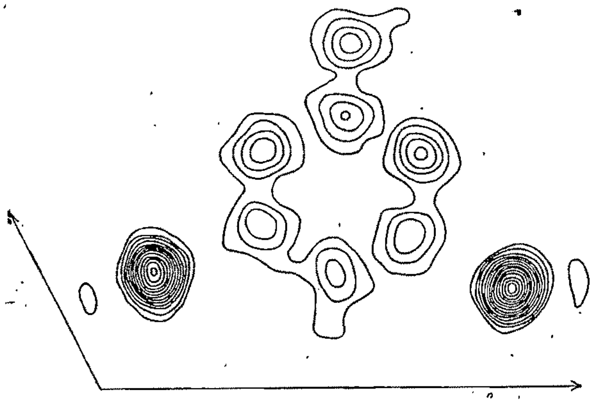


Fig. 1. 2-AMINO-4,6-DICHLOROPYRIMIDINE. ELECTRON DENSITY PROJECTED ON (010). CONTOURS DRAWN AT INTERVALS OF ·2·5 ELECTRONS PER $A.^2$

A similar procedure was adopted for the second compound, and the second Fourier projection is shown in Fig. 2. The approximate equality in height of the peaks in the 4- and 6-substituent positions is of considerable interest, as, of course, one of these should be a chlorine atom and the other a methyl group. The heights of the peaks correspond to a group the scattering power of which is the mean of that of chlorine and carbon atoms. This probably indicates that the chlorine atoms and methyl groups are distributed randomly through the structure in either the 4- or 6-positions, and this idea is supported by the Patterson projections. A similar phenomenon was reported for *p*-bromochlorobenzene by Hendricks[1], although in this case the space group ($P2_1/a$ with two molecules in the unit cell) requires a centro-symmetrical molecule.

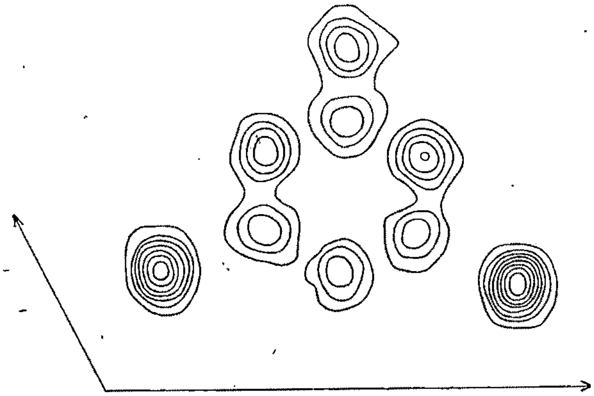


Fig. 2. 2-AMINO-4-METHYL-6 CHLOROPYRIMIDINE. ELECTRON DENSITY PROJECTED ON (010). CONTOURS DRAWN AT INTERVALS OF 2·5 ELECTRONS PER $A.^2$

Although the molecules lie almost in the plane of projection, it is not possible at this stage to give any useful data on bond-lengths and bond-angles. Further work is now in progress, from the results of which it is hoped to derive such information. The structures of *p*-dibromo- and *p*-bromochlorobenzene are also being re-examined with the view of more precise determination.

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Dec. 16.

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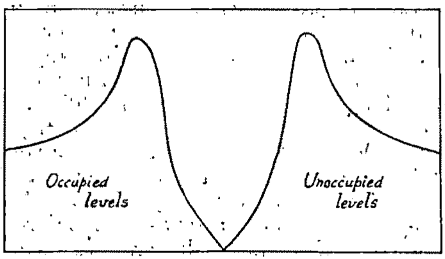
[1] Hendricks, S B., *Z. Krist.*, 84, 85 (1933).

Energy Bands in Graphite

THE graphite crystal is known to consist of parallel planes of carbon atoms. The planes are about $3 \cdot 35$ A. apart, indicating[1] that the binding between them is of long-range, or Van der Waals, type. In each plane the atoms form a regular hexagonal pattern of side $1 \cdot 42$ A. The closeness of this value to that for aromatic systems such as benzene ($1 \cdot 39$ A.) or coronene[2] ($1 \cdot 41$ A.) makes it clear that in any one plane the binding consists of: (i) basic σ-type bonds resembling ordinary chemical single bonds, symmetrical around each C—C direction, and effectively localized in this region; and (ii) mobile (or conduction, or π-) electrons, which are not localized, and the symmetry of which relative to the basal plane is the same as that of a separate $2p_z$-atomic orbital, the z direction lying perpendicular to the plane. The existence of these second electrons gives the metallic character to graphite, and their behaviour may be studied by methods essentially similar to those used[2,3,4] for condensed hydrocarbons. These methods correspond, in usual metal theory, to the 'tight-binding approximation'.

Our first calculations consider the π-electrons in a single plane. These have energies which fall into a band. If we neglect overlap between adjacent $2p_z$-atomic orbitals, this band has symmetry around its mid-point. The accompanying figure shows the density $N(E)$ of energies E. The complete band accommodates two electrons per atom. As there is only one π-electron per atom available, the band is exactly half filled.

The most interesting point about this $N(E)$ curve is the fall to zero value in the middle. In fact, the curve resembles that for an insulator, but with a zero-energy gap between the allowed bands. It shows that, in its basal plane, graphite may be called a true electronic semi-conductor. At absolute zero of temperature, the lower half of the complete band is completely filled, and the upper half completely empty. As the temperature increases above zero,



electrons get into the upper half, but only in small numbers, and conduction is possible. Such conduction increases with temperature. All this is in agreement with known experimental behaviour.

Our calculations, which will be reported more fully elsewhere, have been extended to include the previously neglected overlap integral, and to take account of interaction between the separate graphite planes. The general results described above are not significantly altered.

C. A. COULSON

Physical Chemistry Laboratory,
Oxford. Dec. 25.

[1] Lennard-Jones, J. E., *Trans. Faraday Soc.*, **30**, 58 (1934).

[2] Coulson, C. A., *Nature*, **154**, 797 (1944).

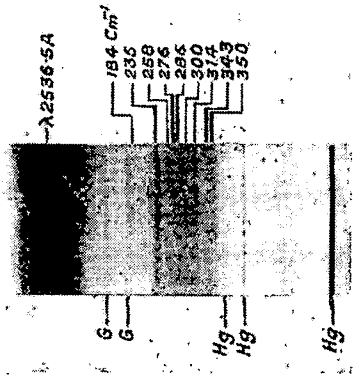
[3] Lennard-Jones, J. E., and Coulson, C. A., *Trans. Faraday Soc.*, **35**, 811 (1939).

[4] Bradburn, M., Coulson, C. A., and Rushbrooke, G. S., *Proc. Roy. Soc. Edin.*, in the press.

Raman Spectrum of Rock-Salt Under High Resolution

THE original investigation of Rasetti[1] as well as my later work[2] on the Raman effect in rock-salt were carried out using a Hilger medium-size quartz spectrograph for recording the faint second-order spectrum. In view of the fundamental importance of the case, it appeared desirable to re-investigate the subject, using the largest possible resolution and dispersion. Various improvements in experimental technique, including especially the efficient filtering of the exciting radiation before its entry into the spectrograph, steady running conditions of the arc and the temperature control of the spectrograph, have enabled me to work with the larger Hilger *E*1 quartz spectrograph for recording the Raman spectrum. Using a fine slit which necessitated an exposure of 160 hours, a record was obtained in which the details are not sensibly obscured by halation and which exhibits the true nature of the spectrum unambiguously.

It will be seen from the reproduction that the spectrum exhibits a set of discrete Raman lines clearly resolved from each other. The positions of the nine prominent lines with their frequency shifts in wave-numbers from the exciting line are indicated above the reproduction. The line with the frequency shift of 235 cm.$^{-1}$, to the sharpness of which Rasetti[1] directed attention in his original investigation, continues to be sharp even under high resolution. The width of this line does not exceed 3 wave-numbers if due allowance is made for the effect of instrumental and photographic factors. Its intensity is more than ten times that of the background on either side. On the longer wave-length side of this prominent line, there is an exceedingly fine line with the frequency shift of 258 cm.$^{-1}$ which is clearly discernible against the background. The intense lines with frequency shifts 300 and 314 cm.$^{-1}$ are also fairly sharp. The pairs of lines with frequency shifts 276, 286 cm.$^{-1}$ and 343, 350 cm.$^{-1}$ have a finite width, but small compared with the width of the peaks in the Born–Bradburn theoretical intensity distribution curve[3].



RAMAN SPECTRUM OF ROCK-SALT TAKEN WITH A HILGER *E*1 QUARTZ SPECTROGRAPH

It may be remarked that in many crystals, for example, diamond[4], quartz[5], calcite[6], etc., the Raman lines which appear extremely sharp at ordinary temperatures broaden to varying extents at higher temperatures. It may therefore be presumed that in the case of rock-salt as well, the observed differences in width of the various lines at room temperature are due to thermal agitation in the crystal. It appears also not unlikely that if the spectrum could be successfully recorded with the crystal held at liquid air temperature, all the lines would appear extremely sharp.

The main conclusion that emerges from the present investigation is that the vibration spectrum of the rock-salt lattice in the infra-red region of frequencies as manifested in the second-order Raman effect is a discrete one, and is different in its nature from that deduced from the lattice dynamics of Born. In view of the results of the present experimental investigation, it does not appear necessary for me to offer any further comments on the points raised by Born[7] in his recent communication in *Nature*.

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Physics Department,
Indian Institute of Science,
Bangalore. Dec. 14.

[1] Rasetti, F., *Nature*, **127**, 626 (1931).

[2] Krishnan, R. S., *Nature*, **156**, 267 (1945); **157**, 623 (1946); *Proc. Ind. Acad. Sci.*, A, **187**, 567 (1946).

[3] Born, M., and Bradburn, M., *Nature*, **156**, 567 (1945).

[4] Krishnan, R. S., *Proc. Ind. Acad. Sci.*, A, **24**, 45 (1946).

[5] Nedungadi, T. M. K., *Proc. Ind. Acad. Sci.*, A, **11**, 86 (1940).

[6] Ornstein and Went, *Physica*, **2**, 503 (1935).

[7] Born, M., *Nature*, **157**, 810 (1946).

THE new photograph of the Raman spectrum of rock-salt seems to me no improvement on previous work, either on that of Rasetti or of Krishnan himself. The dispersion appears to be larger, but not the resolution, so far as it is possible to judge from the reproduction. As no photometric curve is given, Krishnan's contentions about the breadth of the 'lines' are without foundation.

A complete account of the theory by Miss Bradburn and myself has meanwhile appeared[1]. It does not claim to explain all details of the spectrum, because of the simplifications and approximations which were necessary to make the problem tractable. For example, we have replaced the thirty-six branches of the rigorous formula by eighteen, omitting some and merging others. Further, we have neglected factors depending on the frequency, which may easily shift a maximum by 10 per cent of its wave-number, and we have chosen a few intensity factors in such a way that the aspect of the spectrum as a whole is correct, without considering detailed agreement. Thus the 'line' 235 cm. which Krishnan finds particularly sharp could be easily accounted for by giving our branch 9 a different amplitude.

If Krishnan would attack our method of approximation and our wholesale simplifications, I should raise no objection apart from asking him to make it better. But his conclusion that "the second-order Raman effect is a discrete one, and is different in its nature from that deduced from the lattice dynamics of Born", shows that he does not understand the theory, which is a straightforward application of quantum mechanics.

I do not intend to continue this discussion.

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[1] *Proc. Roy. Soc.*, A, 188, 161 (1947).

Diffraction of Light by High-Frequency Ultrasonic Waves

Recently diffraction patterns have been produced in this laboratory[1] by using ultrasonic waves of frequencies higher than 100 Mc./sec. At such high frequencies, the patterns show some interesting features. Progressive waves of frequency 102·6 Mc./sec. and maintained in water have been employed. When the sound wave is exactly normal to the incident light, the diffraction pattern disappears altogether. On tilting the crystal holder to one side or the other, so that the light rays meet the sound wave-front at an angle of 52′, the first-order diffraction line alone on the appropriate side is obtained. This angle agrees closely with the value derived from the equation $\lambda/\lambda^* = 2\,\mu \sin\,\theta$, where λ and λ^* are the wave-lengths employed and μ is the refractive index of water. In no position of the sound wave-front has it been possible to get the first-order line on both sides at the same time. The value of the above angle for which the first-order line attains the maximum intensity is quite critical. Even a slight variation of about 2′ has been found to reduce its intensity to half. Thus the diffraction effect at such high frequencies ($\lambda^* = 0{\cdot}00148$ cm.) appears to be very much like reflexion in the Bragg sense.

Contrary to the above results, we have found that patterns at 50 Mc./sec. show the presence of both the first-order lines for normal incidence. For oblique incidence, the first-order line on the appropriate side increases in intensity as the wave-front is tilted and attains a maximum at the corresponding reflexion angle. The first-order line on the opposite side decreases in intensity but does not vanish altogether, showing that the range of reflexion is not so sharp as in the previous case.

Bär[2], Parthasarathy[3] and others have shown that similar phenomena make their appearance, but in a less pronounced manner, at ordinary frequencies such as about 20 Mc./sec. Our investigations show that when 100 Mc./sec. is reached, the well-known features of diffraction are suppressed and the effect simulates reflexion very closely. It may be mentioned here that Nath[4] had shown that the first order would be dominant over the higher ones in the very high frequency region. Our observations are in conformity with this view.

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Dec. 20.

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[1] Bhagavantam and Ramachandra Rao, *Nature*, 158, 484 (1946).

[2] Bär, *Helv. Phys. Acta*, 9, 265 (1936).

[3] Parthasarathy, *Proc. Ind. Acad. Sci.*, 3, 594 (1936).

[4] Nagendranath, *Proc. Ind. Acad. Sci.*, 8, 499 (1938).

Dimensional Changes Accompanying Capillary Condensation

Banks and Barkas[1] have recently directed attention to the mechanical interaction between capillary condensed liquid and the walls of the pores containing it, and they deduce that under certain conditions the pores may collapse when the vapour pressure over the system is lowered. However, when capillary condensation occurs, the liquid condenses on an adsorbed film—not on a bare surface—and it is to be expected that when the vapour pressure is sufficient to cause condensation of liquid, there will always be present an adsorbed film which is *mobile*. A mobile film exerts a pressure[2] numerically equal to the free-energy lowering per unit surface due to its adsorption, and in a capillary tube this pressure opposes the tension of the condensed liquid. Effects due to the pressure of a surface film have been neglected by Banks and Barkas in their calculations.

The role of the film pressure in this kind of problem may be seen by considering the dimensional changes accompanying adsorption and capillary condensation in a cylindrical cavity with very thin elastic walls. If the cavity is originally *in vacuo*, on adsorption of a vapour the film pressure φ stretches the walls of the cylinder. Changes in radius may be examined by considering the forces acting across a plane containing the axis of the cylinder. At equilibrium there is no net force acting over any imaginary plane cutting an isolated system, so that after adsorption the circumferential tension in the wall of the cylinder is equal and opposite to the film pressure φ, or $k\frac{(r_1-r_0)}{r_0} = \varphi$, where r_1, r_0 are the new and original radii and k is related to the elastic constants of the material. (When the expansion is large k may depend on the expansion; for present purposes it is treated as a constant.) Similarly, the cylinder will increase in length until the total longitudinal tension in the walls balances the longitudinal force ($2\pi r_1\varphi$) of the adsorbed film.

When capillary condensation occurs, the wall of the cavity becomes wetted by liquid and the surface pressure increases to $\varphi + \gamma \cos\theta$, where γ is the surface tension of the liquid and θ is the contact angle.

(*a*) *Changes in Radius.* Supposing the radius to remain constant at r_1, the forces acting over the plane containing the axis of the cylinder would be (i) the tension in the walls $k\frac{(r_1-r_0)}{r_0}$, (ii) the film pressure $(\varphi + \gamma\cos\theta)$, and (iii) the tension in the condensed liquid. This last quantity is $\frac{2\,\gamma\cos\theta}{r_1} \times 2\,r_1 \times 1 = 4\,\gamma\cos\theta$ per unit length, and the total expansive force per unit length acting across the plane would be

$$-\,2k\,\frac{(r_1-r_0)}{r_0} + 2\,(\varphi + \gamma\cos\theta) - 4\,\gamma\cos\theta,$$

which is not zero. Therefore, at constant vapour pressure, the cylinder would *shrink* to a new radius r determined by

$$-2k\frac{(r-r_0)}{r_0}+2(\varphi+\gamma\cos\theta)-2r\cdot\frac{2\gamma\cos\theta}{r_1}=0,$$

or, since $\varphi = k\frac{(r_1-r_0)}{r_0}$, then $\frac{\gamma\cos\theta}{\varphi}=\frac{r_1(r_1-r)}{(r_1-r_0)(2r-r_1)}$.

(*b*) *Changes in Length.* On condensation at the radius r_1, the longitudinal expansive force due to the film pressure would increase by $2\pi r_1\gamma\cos\theta$, but the tensile force of the liquid would be $\frac{2\gamma\cos\theta}{r_1}\times\pi r_1^2$, that is, it would be equal and opposite the increased expansive force of the adsorbed film. Therefore, if the radius remained constant on capillary condensation, there would be no tendency for the length of the cavity to alter. It follows that there would be no dimensional change accompanying condensation in a *spherical* cavity.

However, due to the radial shrinkage from r_1 to r, the longitudinal expansive force is reduced from

$$2\pi r_1(\varphi+\gamma\cos\theta) \text{ to } 2\pi r(\varphi+\gamma\cos\theta);$$

while the longitudinal tensile force of the liquid is reduced by

$$\pi(r_1^2-r^2)\frac{2\gamma\cos\theta}{r_1}.$$

The net decrease in the expansive force is then

$$2\pi(\varphi+\gamma\cos\theta)(r_1-r)-\frac{2\pi\gamma\cos\theta}{r_1}\cdot(r_1^2-r^2),$$

which reduces to

$$\frac{2\pi(r_1-r)}{r_1}\{r_1\varphi-r\gamma\cos\theta\}.$$

Consequently, on capillary condensation, the length of the cavity will decrease, remain constant, or increase according as $r_1\varphi$ is greater than, equal to, or less than $r\gamma\cos\theta$.

These examples illustrate the primary role of the film pressure φ as an influence on the dimensional changes accompanying adsorption. Moreover, the difference between the longitudinal and transverse effects emphasizes the importance attaching to the geometry of the deformable system. The difference between the *form* of the above equations for the radial changes and the equations of Banks and Barkas arises merely from the supposition made above that the wall of the capillary is very thin. For a wall of finite thickness, more complicated equations analogous to those of Banks and Barkas but containing an additional term due to the film pressure would be obtained. It will be noted that on slightly lowering the pressure after capillary condensation has occurred, the reduced radius will cause the liquid to remain in the capillary, that is, the radial shrinkage leads to a hysteresis in the adsorption isotherm.

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Dec. 20.

[1] Banks and Barkas, *Nature*, 158, 341 (1946).

[2] Bangham, *Trans. Faraday Soc.*, 33, 805 (1937).

Binocular Colour Combinations

INTEREST centres round the possibility that a good yellow might be made from a binocular combination of red and green, one colour presented to each eye. According to Walls, "There is no color-sensation which can be produced by mixing two lights in one eye, that cannot be duplicated by supplying two lights, independently, one to each eye"[1]. He also puts forward an interesting theory that all colour syntheses, whether monocular or binocular, take place in a single locus, believed to be the lateral geniculate nucleus (whereas fusion of binocular stereoscopic patterns may take place in the laminæ of the striate area of the visual cortex)[2].

Two colours, one supplied to each eye, may be combined by means of a simple stereoscope fitted with a colour-filter holder in place of the usual stereoscopic double picture. One colour will stimulate each eye independently.

In experiments of this kind, carried out on eleven subjects with normal colour vision, the eight Ilford monochromatic filters were used, together with Ilford Micro No. 6—a suitable purple. The nine colours were combined binocularly in pairs, starting with red on the left and taking each other colour in turn on the right; then placing orange on the left, and taking each colour except red on the right, and so on, until finally purple was combined with violet. In order to compensate for the effect of the dominant eye, whichever it was, the experiment was then repeated with the sides reversed.

The degree of combination was estimated on a ten-point scale, 0 being complete absence of combination and 1·0 being perfect fusion. Five intermediate points were used: 0·1, 0·3, 0·5, 0·7 and 0·9, in order to simplify the task and also because no colour pair completely failed to fuse or gave perfect combination. The estimates were entered in order in a 9 × 9 table, like a correlation table, and the diagonal cells were then filled with 1·0's, because they represent fusion of each colour with itself, which is always perfect.

Such a table may be factorized by the simple summation method of Burt[3], and the following factor loadings were obtained from an experiment with an experienced observer with normal colour vision.

Colours combined	General factor	First bipolar	Second bipolar
Purple	0·648	−0·247	+0·723
Red	0·735	−0·589	+0·197
Orange	0·765	−0·580	−0·076
Yellow	0·867	−0·402	−0·349
Yellow-green	0·839	−0·089	−0·676
Green	0·765	+0·145	−0·641
Blue-green	0·854	+0·638	−0·158
Blue	0·706	+0·551	+0·399
Violet	0·618	+0·573	+0·599

The general factor shows that all colours have a strong combining tendency when presented independently one to each eye in pairs. The bipolar factors show that there are decided limitations in the ways these combinations can be made. Both bipolars show that complementaries are very difficult to combine, and the second bipolar shows clearly that bright colours are difficult to combine with dark.

Red and green can be combined to a certain extent, under the conditions described, but only with considerable difficulty, and little or no support for the Young–Helmholtz theory will be found in this experiment. It clearly supports a four-colour theory of the Hering or Houstoun type, in which opposite colours would be expected to combine by a 'neutralizing' process in one eye, but not when presented separately to the two eyes, whereas neighbouring colours would be expected to combine readily in either way, which they do.

The fact that complementary colours are extremely difficult to combine when presented separately one to each eye, but very easy to combine in one eye alone, also throws doubt on the theory that all colour combinations take place in a single locus of the brain, and not in the retina. It is more likely that complementaries combine in the eye, though neighbouring colours may combine in the brain.

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University, Glasgow.
Jan. 1.

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[1] Walls, G. L., "The Vertebrate Eye", 90 (1942).

[2] Walls, G. L., "The Vertebrate Eye", 331–38 (1942).

[3] Burt, C., "Factors of the Mind" (1940).

Social Science in the Gap between the Royal Society and the British Academy

To which of the two above-named august institutions should research workers in social science look up for recognition, guidance, grants-in-aid, expert criticism, and publication? The recent Clapham Report[1], on the Provision for Social and Economic Research, was drawn up by a committee of nine whose qualifications included three F.B.A., three Litt.D., two Ll.D., one D.Sc., but no F.R.S. This literary preponderance suggests that the appropriate body is the British Academy. But a surer guide is a comparison of publications. Those of the British Academy, though full of literary grace and social interest, scarcely contain any quantitative analysis. I doubt if a correlation coefficient could be found anywhere among them. An article in celebration of Leibniz[2] does not contain any mathematical symbols. On the other hand, the publications of the Royal Society, though full of quantitative analysis, scarcely contain any direct mention of human social relations. To which body should a quantitative analysis of a social problem, therefore, be offered for publication? Apparently to neither. There is thus an awkward gap at the highest level of authority. No such gap was intended when the British Academy was formed[3] in 1902. One of its presidents, Sir Frederic Kenyon, in his presidential address on July 4, 1918, said of academies of learning: "Their normal formation is in two classes, one comprising what we now commonly call humanistic studies, i.e., history, philosophy and philology (in the widest sense of the latter term), the other mathematics and natural science. . . . In this country the Royal Society corresponds to one of these classes. The British Academy was founded to play the other part." Since 1902 social science, like other sciences before it, has become more statistical, more quantitative, more mathematical. To give only one example: there are now many published researches on the intelligence of school-children, and on its correlations with their parentage and other social conditions. The results are important for planning, and their discussion involves matrix algebra[4]. So a gap, unsuspected in 1902, has now opened wide. Fortunately the gap is bridged by a number of specialized societies and journals publishing severally statistics, psychology and economics. In the history of science some of the papers printed in specialized journals have turned out to be quite as important as those printed by the Royal Society; for example, Karl Pearson's χ^2 test appeared in the *Philosophical Magazine* for 1900. Nevertheless, a gap remains, because the specialized societies lack the breadth and the general authority of the senior bodies.

I have here emphasized only one of the aspects of a problem which has been explored in general by a Committee[5] on Scientific Research on Human Institutions appointed by the British Association. Reference should also be made to the review[6] of the Clapham Report by Prof. P. Sargant Florence.

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Kilmun, Argyll.
Dec. 31.

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[1] H.M. Stationery Office. Cmd. 6868.

[2] *Proc. Brit. Acad.*, 23, 193.

[3] "Encyclo. Brit.", fourteenth edition, 1, 85 (1929).

[4] Thomson, Godfrey H., Presidential Address to the British Psychological Society, 1946 (University of London Press).

[5] *The Advancement of Science*, 2, 345 (1943).

[6] *Nature*, 158, 368 (1946).

Relationships between the Assemblages of Plants Fed Upon by Different Insects, and between the Assemblages of Insects that Feed Upon Different Plants

In the course of a recent investigation of the food-plants of the Chrysomelidæ, a family of about 27,000 species of phytophagous beetles, I have tabulated all available records in relation to the systematic groups simultaneously of the beetles and of the food-plants concerned. The results of this investigation have not yet been published, but they lead me to consider that it would be of interest to investigate the extent to which the following propositions are true for insects in general:

If insects of any given species can feed on plants of more than one species, then insects of any other species that can feed on any of these plant species can feed on all these plant species.

If plants of any given species are fed upon by insects of more than one species, then plants of any other species that can be fed upon by any of these insect species can be fed upon by all these insect species.

A priori, these propositions are suggested by analogy. It is at once apparent that they cannot be true without exception, if only because it is known that changes in food-habit are possible in Nature. Moreover, it is an empirical fact that exceptions are observed. Nevertheless, my work on the food-plants of the Chrysomelidæ indicates that these propositions contain a sufficiently large element of truth to be of service in this family as standards for comparison, as bases for prediction, and as indications of possible directions for further observation.

I should welcome the comments of other workers on the extent to which these generalizations are found to be valid and useful in other groups of insects.

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Allometry of the Vertebrate Brain

Fifty years ago, Dubois[1] investigated the relationship between the brain and body-weights of certain mammals. Unaware of the work of Snell[2], he adopted an expression of the form

$$y = bx^{\alpha} \qquad (1)$$

to describe this relationship, where x is body weight, y is brain weight and α and b are parameters to be determined from the observations; α was termed the phylogenetic constant and b the cephalization constant.

Similar results were obtained by Lapicque[3], and the investigation was continued by Girard[4], by Dubois himself[5], and later by Brummelkamp[6]. A considerable number of papers has appeared, and summaries of the results have been given by Ariens Kappers[7] and de Beer[8].

The conclusions of Dubois and his successors may be briefly stated: (1) The phylogenetic constant, α, is invariable for groups of adult animals of different species within a genus or family and has the value 0·56. (2) When adult animals of different sizes but belonging to the same species are considered, the value of α is 0·26. This intra-specific coefficient is known as the ontogenetic constant. (3) The cephalization coefficient, b, is always an integral multiple of $\sqrt{2}$ (Brummelkamp).

Dubois transformed his formula into the form

$$\log y = \log b + \alpha \log x, \qquad (2)$$

and writing

$$\alpha_{ij} = \frac{\log y_i - \log y_j}{\log x_i - \log x_j} \quad \begin{matrix} (i,j = 1, 2 \ldots n) \\ (i > j) \end{matrix}$$
$$= \alpha_q$$

he then selected 'suitable' pairs of values, say k $(k < n)$, calculated the α_q for each pair $(q = 1, 2, 3 \ldots k)$, and finally put

$$\alpha = \frac{1}{k} \sum_{q=1}^{k} \alpha_q.$$

He found that the value of α was approximately 0·56.

This method was ultimately used for a number of groups of animals in order to find both the phylogenetic and ontogenetic constants. Afterwards, the value 0·56 was substituted back into the equation and treated as a kind of universal constant; given y and x, b could then be readily calculated. Various hypotheses as to the magnitude and relationships of the cephalization coefficients were then elaborated.

There is little need to point out the inadequacy of such a method of estimating parameters, and von Bonin[9] saw clearly that such a choice of 'suitable' values begged the whole question of cephalization and the development of higher mental qualities. Moreover, it is obvious that it is impossible to make any comparisons between different values of the parameters since no significance tests could be derived.

During the course of an investigation into the growth and organisation of the vertebrate brain, I have had occasion to consider this allometric formula. The values of the parameters and their standard errors may be estimated by maximum likelihood methods from either of the two forms of the equation (1) and (2). If the logarithmic form is used, the normal equations should be suitably weighted, which, so far as I am aware, has not been adequately recognized up to now. I have, in fact, considered the regression of $\log y$ on $\log x$ and used y^2 as a weighting factor. The justification for the use of this factor will be discussed elsewhere. I have applied this method to the data available to the authors cited—usually to the figures quoted in their papers. It is a little difficult always to decide upon what principle the data were chosen from Hrdlička and Weber, but I have made use of these data with the addition of some observations from Spitzka[10] for the *Macaca* species. It may be noted that frequently mean values of an unspecified number of observations have been used by previous authors as if they had the validity of the observations themselves.

My results are summarized in the accompanying table.

Group of animals	Number in group	Value of $\alpha \pm$ standard error	Value of $b \pm$ standard error
Reptiles	20	0·58±0·13	0·014± 0·05
Birds	25	0·37±0·004	0·69 ± 0·02
Primates	40	0·38±0·0002	5·3 ± 0·02
Rodents	32	0·62±0·005	0·12 ± 0·002
Between Sciuridæ	35	0·60±0·006	0·20 ± 0·005
Between Muridæ	9	0·51±0·04	0·10 ± 0·02
Within Sciuridæ:			
S. rufiventer	5	Not significantly different from zero	8·96 ± 0·28
S. carolin	17		7·60 ± 0·84
S. hudson	7		4·10 ± 0·17
Sciuropt. volans	6		1·96 ± 0·08
Between *Macaca* spp.	75	0·18±0·0001	21 ± 0·001
Within *Macaca* spp.:			
M. cynomolgus	5	Not significantly different from zero	58·5 ± 5·8
M. nemestrinus	8		112·9 ±11·2
M. pileatus	9		63·7 ± 5·1
M. rhesus	53		80·0 ±10·5

It will be seen that the value of the inter-specific (phylogenetic) constant, α, varies widely from the value 0·56. Even in such closely related animals as the Sciuridæ and Muridæ, it can be shown that the values are significantly different.

For all those species which I have considered, the intra-specific (ontogenetic) constant differs from 0·26 and, in fact, does not differ significantly from zero. This implies that if we are justified in fitting an equation of this form, the brains of adult animals of the same species have weights which only vary by random amounts.

In view of these results it would appear that Brummelkamp's hypothesis as to the relationship between cephalization coefficients is untenable.

I must emphasize that I do not consider these data to be adequate for the foundation of hypotheses concerning the quantitative organisation of the brain and the appearance of the higher mental activities in phylogeny or ontogeny. I am inclined to think that the values of parameters estimated from large groups of very different genera, for example, rodents, are of very little interest.

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Dart of an Extinct Mollusc

THE dart in most Belogona is a fragile structure, and although no more perishable than other small calcareous bodies it does not seem to have been found with any frequency as a fossil.

The portion of dart illustrated here is that of the extinct sub-fossil form of *Cepæa nemoralis* L. which occurred in sand dunes at Dog's Bay, Co. Galway, prior to the erosion of the deposit. The mollusc has been referred to the var. *pura* Westerlund (= *ponderosa* Malm.), and a close relative still exists in the Dartry Mountains, Co. Sligo. The fragment, comprising the tip and about a third of the shaft, was

DART OF *C. nemoralis pura* WEST. × *c.* 6

found by sifting material scraped out of a batch of sub-fossil shells sent me by A. W. Stelfox, collected in 1909. It is interesting, in view of the suggested relationship of this form to *C. tonnensis* Sandberger, to notice that the dart is closely similar to that of the living typical *nemoralis*, although it is rather larger.

I can find no previous record of any dart recovered from sub-fossil material. It might be worth searching for more, and it seems possible that careful X-ray examination of palæontological specimens might provide some evidence of the nature of the dart in other extinct forms.

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Detoxicating Effect of Verdoperoxidase on Toxins

A GREEN ferment with peroxidase activity named 'verdoperoxidase' was isolated from leucocytes in 1941, the amount present in cells being estimated as 1–2 per cent[1]. Verdoperoxidase seems to be located in the eosinophile granules, for Neumann[2] showed that eosinophile granules prepared by tryptic digestion of leucocytes were greyish-green in colour and had peroxidase activity.

The localization of verdoperoxidase and the remarkably high content of the ferment in the leucocytes have led me to undertake investigations to ascertain whether it has a special function in combating infectious diseases. Such an assumption is supported by several earlier observations. In severe infectious diseases, the oxidase granules in the polymorphnuclear leucocytes disappear. Injections of oxone (oxidases and peroxidases) from leucocytes and bone-marrow[3] prolonged by a day or so the life of animals infected with *Ty. mur.*, *B. antrax* and *B. recurrens.* According to Kojima[4], phenol is oxidized by peroxidase and hydrogen peroxide to form a substance with bactericidal action. Petherick and Singer[5] studied the detoxication of bactericidal toxins by metal catalysts. In cases of infectious diseases, Möllerström[6] found an increase in the peroxidase content of the blood-plasma. This increase he considered to be due to a release of peroxidases from leucocytes upon their disintegration.

Experiments have now been performed in order to ascertain whether bacterial toxins could be detoxicated by verdoperoxidase in the presence of peroxides. The most suitable peroxide concentration for the verdoperoxidase action is not yet known. At that concentration, 0·0015 *N*, which is used in the determination of the purpurogalline number of the verdoperoxidase, the ferment is gradually inactivated. The experiments described below were therefore arranged in such a way that the hydrogen peroxide content in a mixture of toxin and verdoperoxidase was gradually increased by dialysis up to the concentration 0·001 *N*. In these preliminary experiments dialysis continued for 24 hours; inactivated verdoperoxidase was replaced by additional amounts of fresh ferment after 6, 12 and 18 hours.

Ten ml. of diphtheria toxin were mixed with 0·35 mgm. verdoperoxidase in a 'Cellophane' bag and dialysed for 24 hours against a solution containing NaCl 0·7 per cent, Na_2HPO_4/KH_2PO_4 *m*/150 *p*H 7·4, and H_2O_2 *N*/1,000. Temp. 20° C. After 6, 12 and 18 hours 0·20 mgm. verdoperoxidase was added.

From experiments on animals it appears that toxin treated in this way was detoxicated (see Table 1). In order to make sure that this detoxication was due to the peroxidase effect of the ferment, the following control experiments were carried out:

(1) Diphtheria toxin mixed with 0·20 mgm. crystalline horse radish peroxidase and diphtheria toxin alone were dialysed as described above.

TABLE 1. TIME OF DEATH IN HOURS. THE ANIMALS WERE OBSERVED EVERY THIRD HOUR DURING THE FIRST TWO DAYS AND THEN TWICE A DAY

Toxin concentration	Diphtheria toxin + verdoperoxidase + hydrogen peroxide	Diphtheria toxin + peroxidase + hydrogen peroxide	Diphtheria toxin + hydrogen peroxide	Diphtheria toxin + verdoperoxidase	Diphtheria toxin + peroxidase	Diphtheria toxin
1/10	Both alive	Both alive	18 21	24 27	21 24	18 21
1/30	,,	,,	27 30	27 33	27 36	24 27
1/100	,,	,,	36 40	42 48	33 40	30 40
1/300	,,	,,	56 72	48 64	72 96	72 104
1/1000	,,	,,	96 alive	144 alive	Both alive	168 alive
1/3000	,,	,,	Both alive	Both alive	,,	Both alive

TABLE 2. TIME OF DEATH AFTER INJECTIONS, IN DAYS

Toxin concentration	Tetanus toxin + verdoperoxidase + hydrogen peroxide	Tetanus toxin + peroxidase + hydrogen peroxide	Tetanus toxin + hydrogen peroxide	Tetanus toxin + verdoperoxidase	Tetanus toxin + peroxidase	Tetanus toxin
1/30	All alive	All alive	3; 3; 3	3; 3; 4	3; 3; 3	2; 2; 3
1/100	,,	,,	3; 4; 4	4; 4; 4	4; 4; 4	2; 3; 3
1/300	,,	,,	5; 5; 5	4; 5; 7	6; 6; 7	3; 4; 5
1/1000	,,	,,	5; 6; 8	6; 6; 7	7; 8; 10	5; 5; 6
1/3000	,,	,,	Alive, 7; 11	Alive, 8; 10	8; 8; 11	7; 9; 10
1/10000	,,	,,	All alive	All alive	All alive	All alive

(2) Toxin + verdoperoxidase, toxin + horse radish peroxidase, and toxin alone were dialysed against a solution of the composition described above, but without any hydrogen peroxide. Peroxidase has a purpurogalline number 10–20 times higher than that for verdoperoxidase, and the amount of the former used, 0·20 mgm., was thus somewhat greater than the equivalent of the latter; but it was not necessary to make any further addition of the peroxidase during the experiments.

The dialysed solutions were diluted 10, 30, 10^2, 3×10^2, 10^3 and 3×10^3 times, and 2 ml. of these diluted preparations were injected subcutaneously into guinea pigs. Two animals were used for every dilution. Table 1 shows how long the animals lived after the injections.

Experiments with tetanus toxin have been carried out in the same way as those described above for diphtheria toxin. The toxin was diluted 30, 10^2, 3×10^2, 10^3, 3×10^3 and 10^4 times. 0·5 ml. of the diluted preparations were injected in the caudal veins of mice weighing 14–15 gm. Three animals were used for every dilution. The results are shown in Table 2.

These experiments show that, together with hydrogen peroxide, peroxidases detoxicate diphtheria and tetanus toxins. This is probably one of the functions of verdoperoxidase in the organism. The toxin preparations were not purified, so it is possible that the preparations contain substances which after oxidation inhibit the action of the toxin. It is, however, more probable that the toxin itself contains an oxidizable group responsible for the toxicity.

Experiments are being carried out to ascertain whether the immunizing effect persists for the toxins treated in the manner described above, whether verdoperoxidase can inhibit the toxic effects in animals injected with active toxins, and whether also other toxins may be detoxicated.

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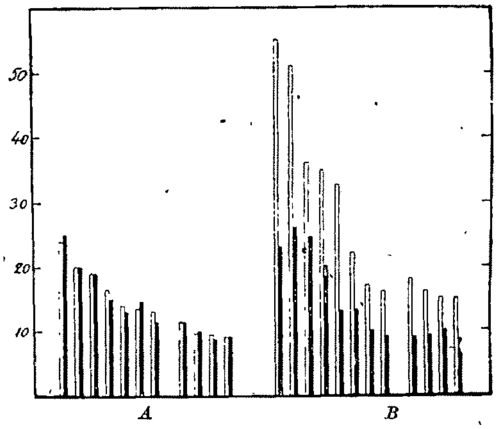
Curative Effects of a Complex Choline Compound on the Impaired Metabolism of Choline-deficient Rats

IN a previous note in *Nature*[1] we have reported experiments showing that impairment of the oxidative metabolism is a very early symptom in choline deficiency; and we concluded that choline is essential for intermediary metabolism, by being used in the formation of an unknown bio-catalyst or coenzyme. Later experiments have emphasized the specificity of choline; the curative effect cannot be produced by injections of methionine or methionine + ethanol amine.

In a series of communications[2-6] we have shown the presence of a new choline compound, the acetylcholine percursor, which is not only the immediate source of liberated acetylcholine, but most probably necessary also for purely muscular functions. We therefore tested the effects of an impure preparation of this substance on the metabolism of minced muscles from choline-deficient rats.

Ox spleen was extracted with ethyl alcohol, which was then concentrated *in vacuo*, washed with ether or petroleum ether, dissolved in water, and precipitated with acetone, as described in an earlier communication[7]. For the experiments we used albino rats, 28 days old, which were placed on the choline-deficient diet already described[1]. They were used for metabolism experiments on the fifth to seventh day on the test diet. Animals with renal hæmorrhages were not used, as uræmia itself slows[4] down the decolorization of methylene blue, and is not influenced by injections of choline. This effect was checked by using normal animals after nephrectomy.



TIME (MIN.) REQUIRED FOR DECOLORIZATION OF METHYLENE BLUE *in vacuo*

A, CONTROLS; *B*, CHOLINE-DEFICIENT RATS

White columns represent the mean of two values on muscles only; black columns adjacent represent the mean of two values from the same muscles with addition of spleen extract corresponding to about 1 gm. of fresh spleen. In each Thunberg tube: 1·250 γ methylene blue, dissolved in 2·5 ml. of m./15 Sörensen phosphate buffer *p*H 7·15, and 0·2 gm. of minced muscles of hind limbs

As seen from the graph, addition of the spleen extract to the Thunberg tubes normalizes the impaired metabolism of minced muscles from choline-deficient rats, but it has practically no effect on muscles from control animals on the same diet plus 0·6 per cent of choline chloride. Thus, the disturbances in metabolism are prevented or cured by choline in the food or in injections, but choline has no effect *in vitro*; it must pass through the organism to be transformed into a bio-catalyst; the extract is effective *in vitro* and probably contains the complete catalyst.

It is not yet possible to decide if the active principle of the extract is identical with the acetylcholine precursor. We know that the precursor decreases in muscles of choline-deficient rats[6]; we know that the metabolic factor probably is a complex choline compound and that this factor and the precursor have the following characters in common: both are soluble in alcohol and in water but insoluble in ether and petroleum ether, both are precipitated from aqueous solution with acetone and barium salts, and both are destroyed when boiled with strong acids but are more stable in slightly acid solutions.

Barium salts added to a watery solution of the acetone powder produce a precipitate; after centrifugation the clear solution is inactive. We have, however, not been able to regain the metabolic factor from the barium precipitate. If a solution of the acetone powder in 2 N hydrochloric acid or in 1 N sodium hydroxide is boiled for 15 minutes, cooled, neutralized and again precipitated with acetone, the precipitate has lost its metabolic activity. At pH 4 it can be boiled for 30 minutes without losing its activity.

Full reports are being published in *Acta Pharmacologica et Toxicologica*.

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A New Unit in Photo-electric Colorimetry

The quantity $E_{1\,\text{cm.}}^{1\,\text{per cent}}$ does not always lend itself to be used in photo-electric colorimetry. As absorption is generally determined where strong bands occur, a 1 per cent solution in a layer of 1 cm. gives in most cases a reading far below the range of sensitivity of the instrument. Furthermore, it will be found that in many cases the Beer–Lambert law cannot be used for extrapolating from $E_{1\,\text{cm.}}^{1\,\text{per cent}}$ values those concentrations which cover the useful parts of the scale.

The use is, therefore, suggested in practical work of the 'half-value' of the substance, that is, the weight (in grams) of a substance which has to be contained in one ml. solvent in order to reduce the transmitted light by a half, the length of path being 1 cm., and the light transmitted by the solvent alone being unity. The proposed symbol for this quantity is $W_{1\,\text{cm.}}^{50}$.

Several advantages are claimed for this suggestion. First it should facilitate the reproduction of data obtained from a different instrument, as it refers to the most sensitive part of the scale; secondly, if, for example, in medical biochemistry, a test has been worked out so as to have its mean at a colorimeter reading of 50 per cent transmission, readings above and below this mean are, over a wide range, practically equally reliable. Often no allowance is made for the fact that the measured transmission depends on extraneous factors as well, such as colour-temperature of the filament, monochromaticity of the filter, and characteristics of the photo-cell. Thus it can be easily shown on a filter-colorimeter that the apparent transmission of a coloured fluid varies when the colour-temperature of the lamp is altered, as the filters are not strictly monochromatic. The steeper the slope of the absorption curve of a fluid, the greater this error will be. For example, solutions of potassium dichromate which exhibit strong absorption in the violet but pass red freely show this phenomenon for blue and green. The use of $W_{1\,\text{cm.}}^{50}$ can overcome part of these difficulties.

In practical work the half-value of a substance is quickly arrived at by taking two concentrations yielding transmissions above and below the half-value. From either concentration $W_{1\,\text{cm.}}^{50}$ is calculated, assuming that the solution obeys the Beer–Lambert law. Both estimates are now pooled. Then two new solutions are prepared, containing slightly more/less than the expected half-value; whence $W_{1\,\text{cm.}}^{50}$ is accurately found.

A worked example of this principle is set out below. Standardized hæmin (for which we wish to thank Prof. E. J. King) is treated with alkali[1]. Its $W_{1\,\text{cm.}}^{50}$ is found to be 0·000 039 4 gm./ml., when determined in a 'Lumetron' photo-electric colorimeter, using a monochromatic Corning glass filter with a peak at 515 mμ. The practical usefulness of such a statement may be greatly enhanced by stating $W_{1\,\text{cm.}}^{50}$ for potassium dichromate under identical conditions (in our case 0·00285 gm./ml.); for in the absence of the original material, the potassium dichromate may serve as a handy secondary standard. When both are available an additional check is afforded.

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Digestibility of Cow's and Buffalo's Milk

The cow is the main animal for milk production in the world. In Africa, Asia and some parts of Europe, the buffalo is used as well as the cow to provide milk for human consumption. In Egypt, the statistics of the Ministry of Agriculture in 1937 record 956,036 buffaloes compared with 983,219 cows. The average composition of cow's and buffalo's milk in Egypt, as a result of a series of analyses of milk given by the Faculty of Agriculture herd for two consecutive years, was found to be as follows:

	Density at 15° C.	Moisture %	Dried subst.	Proteins %	Fats %	Ash %	Lactose %
Cow's milk	1·0325	85·90	14·10	3·75	4·91	0·80	4·66
Buffalo's milk	1·0316	83·01	16·99	4·39	7·30	0·83	4·47

The composition differed mainly in the percentage amount of fat; whereas in cow's milk it was 4·91, it was 7·30 in buffalo's milk. This variation in the amount of fat raised the question whether the high amount of fat in buffalo's milk decreased the digestibility of the other constituents of milk. In Egypt, physicians, under the influence of this notion, have prescribed cow's milk in artificial lactation and clinical dietetics, as it was thought to be more digestible than buffalo's milk. It was therefore thought worth while to test the digestibility of cow's and buffalo's milk.

For this purpose, three sheep, one less and two more than one year old, were selected at the Experimental Station of Animal Nutrition of the Faculty. They were kept separately, each in a metabolism box. Before determining the digestibility of milk, a separate experiment was performed first on the same sheep to measure the digestibility of hay which would be given to supplement the milk. The same sheep then received a measured amount of milk supplemented with a weighed amount of hay. The experiment was divided into two periods: seven days as preliminary period and ten days as original one. The amount of hay and of milk given was just sufficient for maintenance. Cow's milk was used first, and then the experiment was repeated using buffalo's milk. The sample of milk given daily was prepared from the daily mixture of cow's or buffalo's milk collected from the Faculty's herd. A sample of milk as given to the sheep was taken daily, and its density and the percentage of dried matter, fats, proteins and lactose determined. Fæces were collected daily and dried in an oven at 70° C., and then ground at the end of the experiment and kept for analysis.

The final figures for the digestibility of the different constituents of both types of milk from the average figures obtained from the three sheep, with the exception of lactose (means of two sheep only), were as follows:

Coefficient of digestibility of	Dry matter	Proteins	Fats	Lactose
	%	%	%	%
Cow's milk	79·21	83·18	97·07	75·27
Buffalo's milk	77·04	83·87	97·62	74·78

From these results, it can be concluded that the digestibility coefficients of the different constituents of buffalo's milk are practically equal to those of cow's milk. As regards protein digestibility, we have verified this result in a separate experiment using pepsin and hydrochloric acid, when it was found to be 95·01 for cow's milk and 95·47 per cent for buffalo's milk. It seems, therefore, that the relative high amount of fat in buffalo's milk did not affect the digestibility of proteins and fats. The figures of the digestibility coefficients of lactose obtained in our experiment were low, although it is known that the digestibility is very high; this may be attributed to the bacteria present in the stomach of the ruminants. The idea of medical men that cow's milk is preferable to buffalo's milk, in our opinion, has no physiological basis.

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Rancidity in Indian Butter Fat (Ghee)

CHANGES in analytical characteristics following upon the onset of rancidity in butters and butterfats have been widely studied[1-6], with somewhat discrepant results. This is scarcely surprising in view of the number of variables involved, within the material itself and in the conditions of its spoilage. In the work here reported, the samples of ghee were prepared with some care and represent genuine products in good condition; the specimens examined were not chosen at random but belonged to three definite types—one, from Kirkee, of high Reichert value (30–40) and low iodine value (*c.* 28) typical of well-kept dairy buffaloes, another of normal Reichert value (*c.* 25) and iodine value (*c.* 38) from dairy cows, and the third of low Reichert value (14–22) and high iodine value (33–40) derived from buffaloes fed mainly on cotton-seed. The samples had all been stored in similar conditions, namely, in glass bottles with fairly loose-fitting wooden corks placed in a laboratory cupboard for periods of three to four years at a temperature range of 15–25° C. The analytical characteristics of the samples were determined before and after storage, and the average changes in each group were as below.

CHANGES IN THE ANALYTICAL CHARACTERISTICS OF GHEES ON STORAGE

	A. High Reichert value, low iodine value. (11 samples)	*B*. Normal Reichert value, normal iodine value. (12 samples)	*C*. Low Reichert value, high iodine value. (10 samples)
Acid value	+24·9	+10·0	+ 18·2
Peroxide ,,	+69·4	+64·9	+107·8
Reichert ,,	+ 4·3	+ 4·1	+ 3·9
Polenske ,,	+ 1·19	+ 0·93	+ 0·76
Iodine ,,	−10·8	− 8·3	− 16·4
Saponification value	+14·7	+11·1	+ 13·6

In the three groups, changes in individual samples were all very similar to the average changes listed in the above table; while the parallelisms between the alterations in each characteristic suggest that they all proceed from a single general cause. Large increases in acid value (usually also associated with large increases in peroxide values) were almost invariably accompanied by large increases in Reichert, Polenske and saponification value, and, most significantly, by big falls in iodine value. The inverse relation between rise in acidity and loss in iodine value indicated oxidative rancidity as the dominant factor in the normal spoilage of butter-fat in the tropics; this inverse relationship is strikingly evident in the smooth curves obtained when acid values are plotted against iodine value losses.

In a further effort to investigate the course of spoilage, the individual specimens in each of the three groups were mixed and the free fatty acids separated, the characteristics of the rancid product and its neutral and acidic constituent fatty acids being then determined. The free acids from each group had high Reichert and Polenske and saponification values and very low iodine values (14–20). Lower acids had presumably been produced by oxidation of unsaturated acids, mainly oleic, rather than by lipolysis from lower fatty acid glycerides, since the Reichert and Polenske values of the de-acidified ghees closely resembled those of the original specimens when fresh (showing that these glycerides had largely remained intact). The low iodine values contrasted with the high figures obtained for the free fatty acids from rancid butter by Davies[7], and again pointed to a mainly oxidative mechanism producing free acidity in butter-fat as opposed to a lipolytic one (somewhat selective towards oleic glycerides) in butter.

Work is in progress here on the more exact nature of the free fatty acids, an account of which will be published later. The work above reported was carried out at the Department of Biochemistry, Indian Institute of Science, Bangalore, India, and grateful acknowledgment to Mr. B. N. Banerjee and Prof. V. Subrahmanyam is made for their interest in its progress.

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RESPIRATION OF DEVELOPING ANTHERS

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UNDER greenhouse conditions the growth in length of flower buds of *Lilium longiflorum* is exponential over the period of about five weeks preceding anthesis, during which they elongate from about 10 mm. to about 155 mm. Blackman's[1] formula can be fitted satisfactorily to the growth curves, if length is substituted for weight ($L_t = L_0e^{rt}$). Hence, the length of a bud may be taken as an index of its age, and logarithms of bud-lengths may be used in lieu of time in describing the development of the bud. For example, the average value of r, in the terms of this formula, for twenty-six buds the lengths of which were recorded each day from February 11 to April 8, 1946, at greenhouse temperatures fluctuating between average daily limits of 16° C. and 27° C., is 0·0765. At this daily 'interest' rate, a bud would grow in length from 10 mm. to 100 mm. in 30·1 days. Dividing the distance from 10 mm. to 100 mm. on a logarithmic scale of bud-lengths into thirty equal parts produces a linear scale of days.

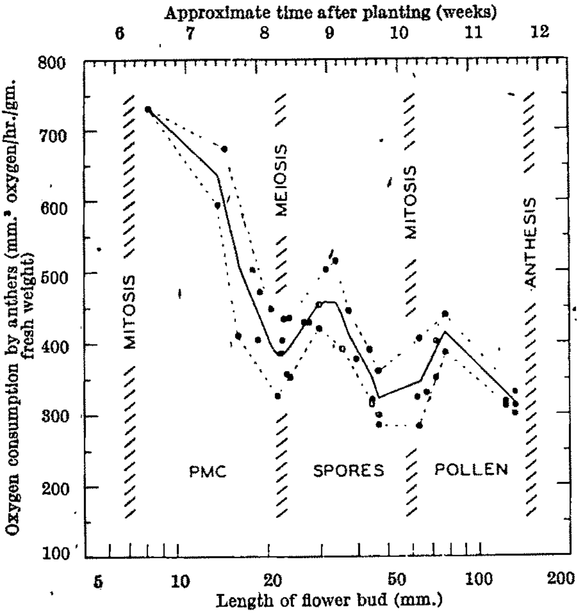
In the development of pollen within the anther, four significant events are: (1) mitotic division of the archesporial cells, which yields sporogenous cells, later microsporocytes; (2) the meiotic divisions of the microsporocytes (pollen mother cells), which yield quartets of microspores; (3) mitosis of the microspore nuclei, which yields binucleate pollen grains; and (4) anthesis, which leads to dehiscence of the anthers and release of the pollen. These four events have been located at the appropriate points on the accompanying figure, on the basis of microscopic examinations of the contents of anthers from buds of known length. The time interval, when $r = 0{\cdot}0765$, between (1) and (2) is about fifteen days; between (2) and (3), about thirteen days; and between (3) and (4), about twelve days. Detailed data supporting these statements will be presented elsewhere.

For all the microsporocytes, microspores or pollen grains within the six anthers of a bud, these nuclear events are much more closely synchronized than in the case of the cells of most other growing organs; for example, a root tip. Since the anther presents at a given time a large number of cells in the same phase of mitotic or meiotic division, it is a favourable object for investigating possible correlations between cytological and physiological processes. Preliminary evidence of one such correlation is reported below.

The respiratory rates of excised whole anthers of *Lilium longiflorum*, from flower buds of various lengths, have been determined at 25° C., in Fenn[2] microrespirometers. Each respirometer vessel contained from one to six anthers, depending on their weight. The anthers were not submerged, nor were the vessels shaken. Readings of oxygen uptake were continued, in most cases, for three hours after dissection of the buds. Determinations of the rate in oxygen, nitrogen, and mixtures of these gases showed that respiration of the anthers was not limited by oxygen tension at tensions greater than one fifth of that in the atmosphere. Rates in air were reasonably constant during the three hours over which most of the determinations extended.

The respiratory rate in air for each sample of one or more anthers, usually during the first hour after dissection, has been plotted in the figure against the length of the bud. A time-scale of days and weeks has been superimposed on that of bud-lengths. The limits within which all the data lie are indicated by broken lines, and the solid line has been drawn midway between these extremes.

The youngest anthers, from a bud 8·1 mm. long, were essentially meristematic in character and respired at the rate of 731 mm.^{3} of oxygen/hr./gm. fresh weight. As the anther differentiates and approaches maturity, there is a general decline in its respiration to less than one half of the original rate. The three oldest anthers studied, from a bud 132·4 mm. long, about two days before anthesis, respired at the average rate of 314 mm.^{3} of oxygen/hr./gm. fresh weight. Such a decline in respiratory intensity is a usual concomitant of development and maturation of plant organs. But superimposed on this decline are two fluctuations which coincide with the meiotic divisions of the microsporocytes, and with mitosis of the microspore nuclei, respectively. Each of these fluctuations consists of a fall below the prevailing respiratory level, and a subsequent recovery. The presumption is that the two fluctuations reflect temporary diminutions, or even cessations, of respiration of the microsporocytes and microspores as they divide. One would expect fluctuations in the respiration of these cells to be damped by the presence of the anther wall and tapetum. It would be desirable, therefore, to determine the respiratory rates of isolated microsporocytes, microspores and pollen.



H. Stern[3] has observed a pronounced increase in permeability of microsporocytes of *Trillium* during meiosis. There is evidence in his data and in those presented here that the division of a cell entails a profound departure from its metabolism during the interphase. Since most studies of the metabolism of growing tissues necessarily integrate the behaviour of many cells at various stages of division, a disturbance of the physiology of single cells during division would not ordinarily be apparent. Further exploration of the possibilities inherent in this study of the physiology of developing anthers may prove to be a profitable means of increasing our understanding of the mechanism of cell division in general, and of the unusual character of the meiotic divisions in particular.

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[1] Blackman, V. H., *Ann. Bot.*, 33, 353 (1919).
[2] Fenn, W. O., *Amer. J. Physiol.*, 84, 110 (1928).
[3] Stern, H., *Trans. Roy. Soc. Canada*, in the press.

NATIONAL RESEARCH COUNCIL OF CANADA

ANNUAL REPORT

THE twenty-ninth annual report of the National Research Council of Canada, 1945–46 (Pp. 65. From the offices of the Council, Ottawa), includes the report of the President, together with reports of the Directors of Divisions, the financial statement and details of scholarships awarded. Among the outstanding developments in 1945–46 mentioned in the President's report are the investigations relating to atomic energy, the release of information on radar research, the design and construction of a plywood tailless aircraft and the development to the pilot-plant stage of a process for butylene glycol from wheat. Gauge inspection work was brought to a close in September 1945, and a building research conference laid plans for co-ordinating studies and initiating practical schemes for the improvement of housing in all its branches, including construction, plumbing, heating, ventilation, lighting and the planning of housing projects with regard to their economic and social aspects. Much work undertaken for the Services as a war measure will be continued in peace-time, but with industrial and commercial applications; for example, applications of radar as aids to air and sea navigation, medical researches on the control of infectious diseases, studies on shock and blood substitutes, the development of plastic prostheses for artificial limbs, studies on heat-retaining properties of textiles used in clothing, shrink resistance of woollens, particularly socks, and wearing qualities of leathers and leather substitutes used in boots.

In the laboratories at Ottawa, the reconversion to peace-time applications of war research and the initiation of new problems are proceeding rapidly; the staff now numbers about 1,400, of whom one half are of professional grade. Through pilot-plant operations, the Structures Laboratory has gained much valuable experience in the use of synthetic resin adhesives, plywood moulding techniques, the application of glueing pressures to complicated assemblies and on the advantages and deficiencies of various glue-lime heating methods and similar problems. A recent inquiry concerning the Kingsville Harbour on Lake Erie handled by the Hydrodynamics Laboratory, in which an alternative was sought to the annual dredging necessary to maintain the navigational channel between the parallel piers protecting the harbour, involved construction of a miniature replica of the harbour and simulation of the conditions affecting the formation of the sand-bar before proposals for the extension of the longer pier could be formulated. Work is also in progress on another model dealing with the formation of sand-bars in the Fraser River.

In the Physics Laboratory, a main objective of work in radiology has been to develop new and improved instruments for the location of radioactive ores and the measurement of such ores and their products. New techniques have been developed for X-ray and radium radiography, and other investigations have dealt with the use of X-ray diffraction and electron microscopy in the examination of catalysts, pigments, rubber-compounding ingredients and other industrial materials. High-voltage research is being continued, and studies are being made of recently developed insulating materials, as well as of improved safety codes, new methods of house wiring and problems of rural electrification. Special electrical problems of the Chalk River atomic energy project are now demanding the attention of the Laboratory, while the Chemical Engineering Section of the Applied Chemistry Branch of the Division of Chemistry is giving attention to the design of the water-treatment plant for the same project as well as to the design of pilot-plant and full-scale plant for the extraction of fissile materials. The echo method of submarine detection is being investigated for its possible use in prospecting and in the detection of flaws in solid structures, while possible industrial uses of high-intensity and high-frequency sound are also being considered. Special investigations in physical oceanography initiated during the War are being continued in collaboration with other Government departments and the Canadian marine industry. A new method of heating houses by floor or ceiling radiant heat panels is being developed, and the effect of window ventilation in severe weather if floors are heated is under examination. Part of the investigation is concerned with the measurement of moisture in wheat and the speed of transference of this moisture from one part of the stored wheat to another, a problem which bears directly on the preservation of wheat from mites.

The Division of Chemistry has now been divided into a Fundamental Branch and an Applied Chemistry Branch; when the new chemical engineering building in the latter Branch has been completed there will be provision for at least three pilot-plants. Industrial researches in progress include work on laundering and cleaning, and interesting results have been obtained on the use and action of detergents and on soil-removal problems. The preservation of fabrics against rot, use of organic rust inhibitors in metal priming paints, silver catalysts for the oxidation of ethylene to ethylene oxide, synthesis of organic compounds containing heavy hydrogen, the chemistry of acetylene, use of acetylene black in rubber compounding, the testing of leather products and plastics and a study of methods for determining carbon monoxide in low concentrations are among other investigations of the Applied Chemistry Branch. About a third of the work of the Division has been concerned with fundamental problems in organic chemistry, including alkaloid studies and synthesis, the kinetics of polymerization and the synthesis of methoxybutadiene, photochemistry, including mercury-photosensitized and other reactions of unsaturated compounds, surface chemistry, such as the electrical resistance and length-changes of activated carbon rods, and studies on macromolecules, and colloid chemistry, including the development of a new and simple film balance which is being used to investigate the properties of gaseous films of fatty acids.

In the Division of Applied Biology, the utilization of agricultural surpluses and wastes, and food investigations have been the two main fields of activity. Two new fermentations studied in the laboratory capable of giving high yields of butylene glycol, with glycerol or formic acid as secondary products, are ready for pilot-plant study. Cyclic methyl ethyl ketal, derived from butylene glycol, shows promise as a blending agent for motor fuels, and aqueous solutions of *l*-butylene glycol appear to be satisfactory anti-freeze substances. A method of separating starch from gluten has been developed, and investigations commenced on the manufacture of wheat syrup. Food investigations during the War were directed almost entirely to the problems involved in the transport of perishable goods to Great Britain, work on egg products being particularly important. Quality-testing methods for use on canned poultry were revised, and it is expected that a plant based on the investigations on Irish moss as a substitute for the agar used in canned meats will shortly come into operation. Many nutritional problems were studied during the War at the request of the Armed Services. Co-operative studies with the Ontario Research Foundation and the Associate Committee on Grain Research were continued on the processing and treatment of domestic oils for edible purposes, and it was found that isolinoleic acid is not the only cause of flavour reversion in linseed oil shortenings. These studies are being continued in an effort to find means of preventing such reversion.

ARTIFICIAL CULTURES IN THE CHICK EMBRYO

"CULTIVATION of Viruses and Rickettsiæ in the Chick Embryo", by W. I. B. Beveridge and F. M. Burnet (*Med. Res. Coun. Spec. Rep. Ser.*, No. 256, 1946. H.M. Stationery Office, 2s. net), is a successor to a previous monograph by Dr. F. M. Burnet published in 1936. The method of growing viruses in the chorioallantoic membranes of the fertile hen's egg was at that time only just beginning. The pioneers of this method have been Burnet in Australia, where so much of this kind of work has been done, and Goodpasture in the United States. The development of the method has been so remarkable that the original technique of inoculating the chorioallantoic membrane is now supplemented by inoculation of the allantoic or amniotic cavities, of the yolk sac, of the veins of the membranes and even of some organs of the embryo itself.

In the present report these techniques are described and the particular difficulties of each are discussed. Important, too, are the notes on appearances in the egg which may be mistaken for lesions produced by viruses, and on bacterial contaminants which occur in some eggs. Useful also are the photographs and diagrams. The advantages of this technique for certain purposes include avoidance of the expense and time involved in the maintenance of small animals, the virtual elimination of cross-infection and the fact that the method gives greater yields of some viruses than can be obtained from any other source. Hen's egg is used, for example, for the production of typhus vaccines, and it can provide enormous yields of influenza virus. The method is also used for the preparation of vaccines against yellow fever and equine encephalomyelitis. A bacteriologically sterile vaccine against smallpox can be made using hen's eggs, but this method has not been widely used. Fertile eggs are also used as sources of certain diagnostic agents, such as Frei antigen, and the reagents needed for Hirst's hæmagglutinin reactions which can be used for the quantitative study of influenza viruses and their antisera.

Dr. Burnet is now director of the Walter and Eliza Hall Institute, Melbourne, where he has worked with Dr. Beveridge and others. This is surely a striking instance of the value in this field of collaboration of a medical man and a veterinarian. Everyone who works with viruses will find this report indispensable. Its thirteen pages of references to work on every aspect of this technique and its uses are by themselves worth more than the very moderate price charged for the whole monograph.

UNIVERSITY LIBRARY SERVICE IN SOUTH AFRICA

THE inaugural address "The University Library, its Function and Potentialities", delivered by Dr. H. Coblans, librarian of Natal University College, Durban, on September 2, 1946 (Pp. 16. Durban: Natal University College), surveys the university library rather from the technical point of view of the librarian himself than from the wider angle of Bruce Truscot in "Red Brick University", and as he is also largely concerned with conditions in South Africa his address may disappoint some whom its title attracts. Dr. Coblans emphasizes the necessity of co-operation and co-ordination in scientific bibliographic service, and looks to the United Nations Educational, Scientific and Cultural Organisation for developments in that direction, urging incidentally the establishment in South Africa of at least one national centre corresponding with the Science Library in London. He recognizes that inclusive documentation may involve radical changes in existing bibliographical methods; but for the research worker, the technologist and the administrator, he considers the key tool should still be the abstract journal.

Dr. Coblans urges the development in South Africa of an inter-library loan system on the lines of that of the National Central Library in Britain, and the development of the essential Union Catalogue as well as the completion of Freer's "Catalogue of Union Periodicals". Directories of library resources, including special collections in industrial laboratories, a greater measure of co-operation at the level of uniform library techniques and standardization, the allocation of subject fields for intensive specialization by particular libraries, the use of microfilm to eliminate some of the huge gaps in South African holdings of scientific and technical periodicals, and to rescue important Africana in a state of rapid deterioration are among his concrete suggestions for improving bibliographic conditions in South Africa. Government support or subsidy and central organisation are also needed. The Council for Education, Sociological and Humanistic Research formed early last year has among its objects the promotion of library services and the provision of information services as well as assistance in the publication of results and other materials likely to be valuable for research.

Dr. Coblans then proceeds to discuss the informative rather than the distributive functions of the university, its work not merely in providing research materials for the scholar but also in bringing knowledge to the service of industry, municipal planning, health and social services. He regards it as the university librarian's task to provide the bibliographies needed, to guide inquirers to the best sources, to integrate and correlate the material. The librarian must know where and how to look, and much higher standards of education and of subject-specialization are accordingly demanded in library staff, while provision of the specialized information equally demands adequate provision of library tools in the way of catalogues, classification schemes and the like. Dr. Coblans sees, too, the library as an integrating influence, seeking to overcome departmental exclusiveness and over-specialization; and in recognizing the educational value of the new mediums such as films, he refers pointedly to factors which have obstructed the use of educational films in South Africa.

In conclusion, returning to the gaps in South African records and bibliographical tools, Dr. Coblans pleads for more comprehensive subject indexes to South African periodicals, newspapers and Government publications, for regular abstracts of research papers published in South Africa, for a register of all South African learned and technical societies and a directory of special collections; and he suggests that the four libraries in Natal University College should form a unit for bibliographical and information service to the province of Natal and the eastern seaboard and ultimately develop a university press.

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FUNDAMENTALS OF INCREASED PRODUCTIVITY

THE "Statement on the Economic Considerations Affecting Relations between Employers and Workers", which was issued as a White Paper in January (Cmd. 7018. H.M. Stationery Office. 2*d.* net), followed hard on a *Planning* broadsheet, "Men, Management and Machines", which hammered out the same imperative need for a higher output from each man and woman. Whereas, however, the White Paper gives no hint as to how this increase in productivity is to be secured, the broadsheet makes some concrete suggestions, and presses implications of the present man-power situation on which Lord Beveridge touched nearly three years ago in a chapter of his book, "Full Employment in a Free Society". The White Paper, in fact, derives its importance from the open admission by the Government, endorsed by both sides of the National Joint Advisory Council, of the extremely serious economic position of Great Britain. It is a clear and forcefully written statement of facts that neither the Government nor the trade unions have hitherto cared to admit.

The gist of the White Paper is easily summarized. Most of its arguments, in fact, have been pressed by every impartial commentator for the last eighteen months. We have for the last seven years "deliberately distorted and unbalanced our economic system, suffered the loss and permitted the depreciation of our capital resources, sold at least half of our external capital assets and gone into debt abroad. . . . This country is still running into debt abroad. Each month our balance of overseas payments is still unfavourable. Nevertheless, since the end of the war this country has proceeded rapidly to establish schemes of social improvements in the way of a housing programme and improved educational system, comprehensive old age, unemployment and health insurance systems and medical and other services". Moreover, the output of consumer goods from domestic industries is still inadequate, and until the output of British industry is considerably increased there is bound to be some fear of our ability to maintain the stability of prices and the orderliness within our industrial system which have characterized Great Britain throughout all the difficulties of the War.

The over-riding factor is the shortage of man-power. The fourteen industries specified, including coal-mining, all the textile industries, several metal-working, the clothing, footwear, furniture, paper and printing industries, needed in November 1946 a further 657,000 workers, or an increase of twenty-two per cent, to regain their total of mid-1939. There is no source from which all this additional labour can be drawn ; on the contrary, the impending raising of the school-leaving age will reduce the total labour force by 370,000 juveniles. Furthermore, while our total working population was about 20,324,000 in November 1946, or about 570,000 more than at mid-1939, this includes 4,985,000 in the Forces and Auxiliary Services, Government services, fire and police services, the professions, entertainment and sport, leaving a balance of 241,000 smaller than in 1939; and the total is expected to fall to the pre-war level by 1948 owing to the fall in birth-rate and the further raising of the school-leaving age. Thus only an increase in output per head can provide an increased supply of goods from home industry and prevent a fall in the flow of imports as soon as the dollar loans are spent. The threat of inflation will remain while only £6,000 million of consumer goods and services face £7,000 million of incomes.

There is clear warning that without high production full employment itself is endangered, and that whether the standard of living can be improved depends on the output and efficiency of all our industries and essential services. The Government affirms its intention of maintaining control and ensuring that no unregulated increase occurs in the prices of essential goods and services; but it places fairly on the shoulders of both sides of industry the responsibility for steadying the costs of production, manning the essential industries and stepping up production until we have struck a balance between total demand and total supply.

In effect, the White Paper is an appeal, issued by the Government, and endorsed both by employers and by the trades unions. The *Planning* broadsheet shows a much clearer grasp of the magnitude and implications of the problem, and indicates some of the lines which Government policy must take, even at the cost of a break with past practice. It indicates rather more precisely the magnitude of our task in the production of capital goods and consumers' durable goods in quantities sufficient to meet arrears due to six years of war and replacements of material destroyed, including, for example, the provision of 750,000 new dwellings to meet immediate requirements, before starting on the extra three millions needed in the next ten or twelve years. Furthermore, the broadsheet directs attention to our commitments in Germany, where our joint responsibility in effect involves subsidizing for some time to come an additional population of about twenty-two millions.

On the labour force, *Planning* makes some pertinent comments. Our working population has increased since 1939 by about 3·3 per cent, solely in the number of women workers, and since the total population has increased by about the same proportion, the increase is not of itself likely to raise real income per head of population. Moreover, changes impending in our age-structure are likely to make for lower, rather than higher, total output. Hours of work are often shorter than before the War; and the increase in the number of paid workers not only necessitates, and may help to produce, an increase in output, but also increases the demand for labour in the transport, catering and entertainments industries.

On this question of deployment of the labour and mobility, *Planning* is much more realistic than the White Paper; and in the face of the arguments put forward it will be difficult to justify claims for shorter working hours as in the public interest. The corollary to the forty-hour week of an even greater increase in output per man-hour is driven home; and in view of some conflicting evidence it might be well worth while for some objective inquiry to be put in hand on that point, as was suggested by the Chief Inspector of Factories when he observed in his 1944 report that much research was still needed before the relation of output to hours of work was fully known, and that close scientific study of these and kindred problems would amply repay the time and effort involved. Even more realistically, the *Planning* broadsheet proceeds to inquire into actual performance and, to say the least, there is little evidence to be adduced that the productivity of industry has increased at all since before the War. Data in some industries are admittedly scanty; but the broadsheet states that in the coal, cotton, iron and steel and even the building industries, output per man-hour is appreciably lower than before the War.

The most valuable section of the broadsheet is the analysis of some of the causes which follows the discussion of performance. Except for coal-mining, where absenteeism may account for nearly half the drop in output per worker since 1939, the proportion said to be attributable to absenteeism and reduced physical effort is probably much less than half. Some of the causes may indeed well be temporary. Staleness, resentment at loss of high war-time earnings, lack of goods in the shops, housing and other family troubles precipitated by the end of the War, and taxation of wages under the 'pay-as-you-earn' system are obvious factors militating against regular attendance and maximum physical effort. Other causes of low productivity, which may also be temporary apart from those obvious difficulties of production planning, lay-out, training and re-tooling involved in re-conversion, may be seen in the shifting of the labour force, more than one third of which has changed jobs since the War, the acquisition of new peace-time skills, the poor condition of plant in many factories, and the difficulty under present conditions of planning production so that output is high and steady.

While, apparently, these are temporary factors which should gradually disappear, they are too interlocked to warrant excessive optimism; and some at least can be eliminated more by Government policy than by any other means. That is true of taxation and to some extent of raw materials and components, which are probably the greatest single cause of low productivity in manufacturing industry. The broadsheet quotes from a pointed article in the *Board of Trade Journal* of November 23, 1946, which shows that there is scarcely a major industry which is not, directly or indirectly, a consumer of raw materials listed as likely to be insufficient to meet demand during the next twelve months. The position is confirmed by the *Monthly Digest of Statistics* for November, and on top of all this there is the problem of fuel, the importance of which has recently been suddenly—and unnecessarily suddenly—brought home to everyone in the British Isles.

Taking a long view and ignoring short-term adjustments, industry itself could increase output per worker in three ways which are to some extent interdependent: by more regular attendance and increased industry on the part of workers; by increased mechanization and more efficient machines and tools; and by better organisation and management. The first of these is essentially a question of improved morale, which usually will depend on a better understanding brought about by improvements in working conditions, involving the persuasion by the actions and attitude of management, rather than by official propaganda, that production is indeed a common task. It is here that contributions such as those of Dr. Mayo in his "The Social Problems of an Industrial Civilisation" are so important; for as *Planning* points out, concrete improvements in working conditions in themselves are not enough—and indeed amenities can be provided at too great a cost both in money and labour.

As *Planning* observes, the essence of management is getting people to do things, and for this it is necessary to understand people and to treat them properly. Special stress is laid in this broadsheet on two particular qualities: a sense of partnership with labour and a sense of service to the community; and, in referring to the value of joint consultation, the importance of giving the worker adequate information is stressed. That is endorsed by all the experience cited by Dr. Mayo, and the broadsheet once again emphasizes the vital responsibility of management in this field of human relations, and also that industrial management has its own contribution to make towards improving the relations between industry and Government.

Such considerations alone would emphasize the importance of the British Institute of Management, the composition of the Council of which has recently been announced. The association with this new enterprise of such men as Sir Clive Baillieu, Mr. C. G. Renold, Dr. J. E. Myers, Lieut.-Colonel L. Urwick, Sir Archibald McKinstry, Sir George Schuster and Mr. T. G. Rose gives every reason for confidence that the Institute will indeed raise the standard of management by helping to provide the right men with the right training and ideas. But as *Planning* pertinently observes, first-class recruits will not be found, nor will our present industrial leaders give of their best, while every manager is liable to indiscriminate political denigration—to be stigmatized by one side as a mercenary exploiter if he works for private enterprise, and by the other as an incompetent bureaucrat if he works in a nationalized industry.

Even from this brief survey, it is clear that there are several directions in which Government policy and action should and must reinforce the exhortations of the White Paper and whatever industry itself can do on either side. In the first place, it is primarily by Government action that the total labour force can be increased. The broadsheet refers to the importance of large-scale selective immigration, and powerful pleas have already been voiced for a deliberate policy of recruiting foreign workers for agriculture and for the mines. In particular, Prof. L. Robbins has argued convincingly for the use of an extra 100,000 such workers in the coal mines of Britain.

Nor is this the only way in which Government action could help. Taxation policy could be revised so as to invite the return of married women to industry, and intelligently administered pension schemes would encourage the able-bodied to continue at work even if only part-time. Taxation policy might also play a big part in increasing incentives to work; indeed, the desperate need for more production is sufficient reason for a critical review of the whole direct taxation system, and particularly that of 'pay-as-you-earn', from the point of view of incentives. Closely akin is the formulation of a consistent wage policy in which payment by results has an effective place, while finally the Government could, and should, overhaul the whole apparatus of economic control through one authority above the departmental level and competent to abolish those controls the usefulness of which is outweighed by the resources of time and labour they absorb, and to co-ordinate and simplify those that remain.

Such a review could undoubtedly make a direct contribution to the efficiency and pace of production, and would also be of value indirectly for its psychological effect on incentives. Equally, however, it is incumbent on the Government to review closely its whole use of man-power in the Services and to see that Great Britain's commitments are in keeping with her resources. That point was well raised in a House of Lords debate on January 29, which not only questioned whether we had the resources to maintain indefinitely a strong navy as well as a standing army of approaching a million, particularly in view of the declining numbers of young men reaching the age of eighteen each year, but also directed attention to the possibility of the Colonial territories supplying man-power necessary for overseas stations.

Both Prof. H. J. Laski and Lord Beveridge have pointed to the new functions which the trade unions and other professional organisations have to perform in conditions of full employment, and recent unofficial strikes emphasize the necessity for early and close attention to such matters as incentives, public relations, education and training, and the whole internal structure and organisation of the trade unions; this is necessary to enable the trade unions to make the great contribution which with wise leaders in close touch with the membership they undoubtedly could give to the well-being of a free society. As their defensive role diminishes in importance, so their constructive, positive contribution becomes potentially greater and more important. Prof. J. Jewkes has pointed out that acceptance of the policy of full employment will necessitate hard thinking by the trade unions regarding their future policy, and he suggests that such thinking might well start with a purely objective analysis of their past procedure. Indeed, if wage differentials are to be used to effect redistribution of labour, an examination of past practice is the basis for a decision as to the extent and speed at which such redistribution is possible.

No matter how wise and sound may be the Government policy and proposals for increasing productivity, a high degree of courage and skill will be demanded of the Government in bringing the public to understand and accept measures which, in some quarters and at some times, are bound to be unpalatable. For this reason, the White Paper is a call to every unprejudiced citizen to help the creation of a sound and informed public opinion on the matter, and to see that criticism of Government policy is both fair and responsible. That is essential if fresh incentives are to be found and industrial discipline maintained in the new conditions of full employment by a further change in the status of the work-people and by their assumption of a larger share in industrial management. Full employment, as Lord Beveridge has pointed out, ultimately depends on how private citizens use their liberties.

THE BRONZE ART OF ANCIENT CHINA

A Descriptive and Illustrative Catalogue of Chinese Bronzes acquired during the Administration of John Ellerton Lodge

Compiled by the Staff of the Freer Gallery of Art. (Smithsonian Institution Publication 3805: Freer Gallery of Art Oriental Studies No. 3.) Pp. v+108+50 plates. (Washington, D.C.: Government Printing Office, 1946.)

IT is probable that anyone who came in contact with John Ellerton Lodge will be left with a strong impression of a man with a great sense of quality—quality of conception as well as of execution—as is suggested in the preface to the volume descriptive of Chinese bronzes added to the collection of the Freer Gallery during the twenty-two years that he was director, from its first year as a public institution until his death in 1942. This volume is designed as a memorial to the man and a record of his work; it contains a few notes from his hand, but these were not written for publication and are little more than memoranda. It is the collections themselves and in particular the fifty-six archaic Chinese bronzes here reproduced in large-scale photographs which are the true monument; but even they will be touched by a finer light for those who can recall Lodge and his appreciation. They will value the portrait included in this catalogue.

A brief introduction of four pages is prefixed to the volume by Mr. A. E. Wenley, surveying the present state of the study of Chinese bronzes and taking a cautious view of the position reached in interpreting the historical inscriptions as material for dating and also of the stylistic sequences proposed by such authorities as Karlgren and Jung Keng. While recognizing that the work done by these scholars in the classification of the decoration "is most important and contains much of the truth", he adds justly that our present knowledge of the subject is still inconclusive, and the bulk of the scientific archæological work is still to be done. He and his collaborator, J. A. Pope, have, therefore, only attempted a division of the Pre-Han Bronzes into Shang, Chou, and late Chou, and have regarded their task as "telling something about individual pieces"; but this, of course, does involve some general principles, though the self-denying method adopted prevents the authors from explaining what these are. What, for example, in the general quality and treatment of the Kuei on Plate XXVIII do they hold must strongly suggest a date later than Shang?

The notes given beneath the descriptions of the pieces are for the most part concerned with the inscriptions; but parallels for the decoration are sometimes adduced and declared to be characteristic of this or that period. This dry objective treatment is rather characteristic of the Chinese approach to the subject; but some of Lodge's own notes treat more of the structure and form of the vessels, as of Nos. 13 and 14, and show a confident sense of style as a criterion of period. But they are equally notable for their careful observation of significant detail. The long and important inscription on the covered vessel fang-i (Plates XXI and XXII) is discussed at some length by Mr. Wenley, with reference also to Sir Neil Malcolm's well-known inscribed Kuei and to Chinese controversialists; but the important fact about both vessels is that these inscriptions are generally agreed to refer them to the eleventh century B.C., early in the Chou Dynasty. They show a baroque profile, and it is noticeable that the vessels assigned by the authors to earlier dates show less relief. Though this fang-i does not bear the name Ch'en Ch'en included in the inscription, it is associated with a group which does, and is said to have formed part of a find of about thirty-five ritual vessels at Lo-yang in Honan. Mr. Wenley points out that if the whole group is to be assigned to the same period (which must be the eleventh century B.C.), then "a considerable change must be forthcoming in methods of dating on stylistic grounds alone"; for the variations are great. But this does not altogether vitiate a stylistic basis for the chronology of each type of vessel, which alone seems a scholarly line to follow. There is, however, much value in the remark made by Mr. Wenley, that geographical factors are likely to differentiate styles as well as the time element.

Several of the vessels here published are of very rare, or in our present knowledge unique, shapes, such as the Huo with cover in the form of a human face with bottle-shaped horns, and the pair of tigers said to have been found in Shensi, apparently some kind of incense burners. Heading the mirrors is an interesting late Chou example with bird decoration from J. H. Cox's excavations at Ch'ang-sha in Hunan. The type is recognized as of Shou-chow, and though this is almost four hundred miles away, Mr. Pope points out that both places were within the confines of the great 'extra-China' State of Ch'u in the third century B.C. Another very interesting mirror, Plate XXXVII, is extensively inlaid with a gold and silver design of entwined dragons, characteristic of the Warring States period. The technical difficulty involved in this kind of decoration on a mirror has been overcome by setting the true mirror of speculum metal in a case of ordinary bronze. Various types of inscribed Han mirrors are represented by examples in remarkable preservation, the rarest being No. 39.38, which is decorated with alternate masks of dragons and tigers, and dated A.D. 174.

The ritual weapons illustrated are a remarkable group, there being no less than five inlaid with turquoise, and of these three have jade blades. The ceremonial 'Sickle' is the most extraordinary of all. It measures nearly 14 in. in length and may well originally have had a wooden handle inserted between the butt and the haft. The position of the blade seems scarcely to justify the name assigned to it, and it seems better to regard it as an example of ritual Ko similar to a number of others of which the jade blades only have survived, though admittedly not exactly of the form here found. Eleven of the weapons illustrated come from a group of twelve acquired with a romantic story of their discovery at Hsun-hsien, Honan, in 1931. Whatever the truth of the story, the fact remains that one here reproduced on Plate XLVII is inscribed with the name Marquis K'ang, which may well be the same name as that occurring on General Malcolm's Kuei which, as noted above, can be assigned to the eleventh century B.C. A feature of these weapons is the presence on three of them of figures or heads of monsters which in two cases are engulfing human figures. This would connect them with the well-known pair of bronze vessels with a similar motif in the round which were exhibited together at Burlington House in 1935–36. Its true significance has still to be explained.

The volume contains a bibliography of ninety-four publications, mainly recent, several of which do not seem to have yet reached Great Britain. It provides just the material which is required at the present stage of the study of archaic Chinese bronzes, and the authors can feel that it will stand the test of time and so be a lasting memorial to J. E. Lodge. It is to be hoped that it may be followed by similar volumes dealing with the other principal acquisitions which he made in the Departments of Persian and Chinese Painting, and Indian and Chinese Sculpture, including jade, of the Freer Galleries. They should be sure of a warm welcome not only from scholars, but also from all lovers of the art of the East, of which Lodge was such a discriminating judge.

BASIL GRAY

A MERRILL FESTSCHRIFT

Merrilleana

A Selection from the General Writings of Prof. Elmer Drew Merrill. (Chronica Botanica, Vol. 10, No. 3–4.) Pp. 127+394. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1946.) 4 dollars.

DR. E. D. MERRILL was born at East Auburn, a suburb in Auburn, Maine, on October 15, 1876. In the seventy years of his life he has made such contributions to the study of botany that the editor of *Chronica Botanica* records his being introduced, to Swedish botanists visiting Harvard, as the American Linnæus. His first botanical paper appeared in 1899, and the mere list of his publications (the vast majority strictly botanical, and including some still in the press) occupies thirteen and a half octavo pages.

The present work is a happy gesture of friendship to Dr. Merrill in the year of his seventieth birthday and of his retirement from the directorship of the Arnold Arboretum. In addition to a chronological list of important events in his life and another of his publications, there is reprinted a selection from the more generally interesting of his works, mainly on taxonomy, phytogeography, and economic botany.

Merrill's main researches have been connected with the flora of Malaysia and especially with that of the Philippines. His earliest botanical papers dealt with North American plants. With his appointment in 1902 as botanist to the Bureau of Agriculture and Forestry, Manila, began his connexion with the flora of the Philippine Islands. Among many other activities, he initiated the herbarium of the Bureau of Science, Manila, the first specimens being those collected by him in 1902. Twenty years later the herbarium contained 275,000 mounted specimens. It is one of the tragedies of the Second World War that this fine collection was entirely destroyed in 1945 during the re-occupation of Manila in the final phases of the Japanese defeat. All taxonomists must sympathize with Dr. Merrill in his feelings of personal loss. It is no doubt some consolation to him, and to taxonomists generally, that thanks to his methods, and to his generosity, so much material was collected for duplicate sets which were distributed to other botanical institutions. Typification and the settling of other botanical problems necessitating re-examination of specimens is thus going to be a much easier task than it might otherwise have been. In this, as in other respects, taxonomists might well follow Dr. Merrill's example.

On the whole, a judicious selection has been made of papers, or extracts, for reprinting. One misses an example of Merrill's more strictly taxonomic work and would have welcomed at least one paper to illustrate his precise, lucid and well-balanced style in preparing descriptions. Of the twenty-three reprints, those likely to be of widest interest are the ones connected with the plant geography of Malaysia and with the distribution of economic plants. It is obvious in reading or re-reading these contributions how Merrill avoids accepting any hypothesis, more or less newly put forward, as an explanation of all problems connected with the distribution of plants. Again and again he shows his caution by reminding his readers how incomplete is our knowledge of the flora and vegetation of these wide-flung tropical lands. In dealing with cultivated plants he adversely criticizes the extreme diffusionist hypothesis that civilization, and with it all important methods in agriculture and many crop plants, arose only once, and then in the Nile Valley. He is strongly against any belief in such supposed lost continental lands as Atlantis and Mu, and his arguments that all such conceptions should be subjected to the acid test of biological facts are typical of his well-reasoned outlook on major problems of plant history.

W. B. TURRILL

EXPERIMENTAL PHYSICS

Analytical Experimental Physics

By Prof. Harvey Brace Lemon and Assoc. Prof. Michael Ference, Jr. Revised edition. Pp. xvi+588. (Chicago: University of Chicago Press; London: Cambridge University Press, 1946.) 33*s*.

IN revising their work for its second edition, Profs. Lemon and Ference have added some eighteen pages of new material, including many of the more recent developments in electronics and nuclear physics. The betatron, the cavity magnetron, the general principles of radar, and nuclear fission, are among the new topics mentioned. The treatment of the triode has been expanded, though the only hint as to its rectifying action is contained in an artist's design at the head of Chapter 33, which looks like one of the relevant graphs.

It is stated that the first edition of the book was selected as one of the sixty best-designed text-books of 1943 by the American Institute of Graphic Arts.

It must be unusual to find a physics book appraised by this standard, but it is an unusually well-illustrated book. Sequences of photographs are used to follow the progress of demonstration experiments; these contain in themselves material for detailed study and some interesting work with pencil and paper. Only one sequence fails to deliver its message; plate 54 shows a series of cinematograph frames of progressive waves, numbered at irregular intervals, and when the key to the arrangement has been found it appears that the period of the waves is twice that stated in the captions.

The general excellence of the book was commended in these columns when it first appeared, and the upper limit of its possible usefulness to university students in Great Britain was then considered. The present reviewer, thinking of its adaptability for use in schools, finds that some two-thirds of the work covers the ground of the usual advanced courses in secondary schools, and that the remainder, while beyond this standard, is presented so clearly that a good pupil interested in reading beyond the limits of his syllabus could readily follow it. Some parts of the 'syllabus' work are done in less detail than is customary in Britain, but this is amply compensated by the full and careful treatment of experimental dynamics, physical optics, and wave motion. It can be recommended as a valuable addition to the school science library, and the paper and binding are such as to stand up to the constant hard use it would sustain in this capacity. G. R. NOAKES

PIEZOELECTRICITY

Piezoelectricity

An Introduction to the Theory and Applications of Electromechanical Phenomena in Crystals. By Prof. Walter Guyton Cady. (International Series in Pure and Applied Physics.) Pp. xxiii+806. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 9 dollars.

THE production of electric charges on certain crystals by the application of pressure was discovered by the brothers Curie in 1880. Until the First World War the phenomena were of scientific interest only, but with the researches of Langevin and Rutherford the use of ultrasonic waves became important in warfare at sea. Between the two Wars piezoelectricity became of great importance to radio in the control of frequency. During the Second World War millions of piezoelectric crystals were made for use in communications both by radio and by telephone. Corresponding to this intense industrial activity there has been a great development of the theoretical aspects of the subject.

The present volume has appeared at the end of one of the periods of most rapid development of the subject of piezoelectricity, and it is written by one who has contributed personally in large measure to that development. In its 806 pages it gives a comprehensive, detailed and reliable account of the subject, and it is at the same time a reference work and a text-book. It is mainly theoretical in treatment; few descriptions of apparatus occur, and the practical details of measurement are scanty. A few electrical circuits are given, but in general only the main features of these are mentioned.

The first seven chapters are concerned with fundamental theory of crystal elasticity, including vibrations in crystals, and the dielectric properties of crystals. One important feature of these chapters is the explicit formulation of the various elastic and dielectric properties for plates and bars of any arbitrary orientation. For those who have occasion to work in this field, these detailed tables will be of great help. Chapters 8–12 deal with fundamental piezoelectric theory. This is one of the most valuable parts of the book, for it compares in a most lucid manner the various theories which have been advanced. Coming, as it does, just after the recent intensive study of the Rochelle salt group of crystals, this section of the book is most welcome, as it puts into proper perspective the relation between the piezoelectric properties of the Seignette-electric and the quartz-like groups of crystals. Chapters 13–18 discuss piezoelectric resonators—the theory, an outline of the methods of manufacture, the influences of air-gaps, electrodes and special cuts both for quartz and other crystals. Chapter 19 is devoted to the piezoelectric oscillator. The next 140 pages, Chapters 20–27, are concerned with the Seignette-electric crystals. The properties of Rochelle salt are exhaustively described on the basis of a critical survey of the literature. This is a most involved subject, largely because so much of the original work was done without a full appreciation of all the factors which affect the results, and the new reader will be grateful for this clear analysis. The last five chapters deal with certain applications of the phenomena of piezoelectricity, pyroelectricity, certain optical effects in crystals, a sketch of the atomic theory of piezoelectricity and a brief account of ferromagnetism designed to show its relation to the properties of the Seignette-electric crystals.

In the introductory chapter on crystallography there are a few points which might have been better expressed. On p. 15 a polar axis is defined as one "having at its two ends faces of different forms, with different numerical indices". This unqualified definition would not be accepted by crystallographers. Similarly, the statement "such vectorial effects as pyro- and piezoelectricity are found only with crystals having polar axes" is scarcely consistent with the piezoelectric character of class (222). It is also unfortunate that although the Hermann-Mauguin notation is mentioned in the introduction, it is not used in the text. Giving numbers to the crystal classes instead of the now accepted international symbols is a retrograde step. On p. 16 the statement "Two opposite vertices of a rhombohedron lie on the trigonal axis, thus forming a three-sided pyramid at each end of the crystal" will be confusing to the student who has been taught to distinguish between rhombohedra and pyramids as separate forms. On p. 34 the definition of a stereographic projection appears to exclude the possibility of points occurring outside the primitive circle. Crystallographers will also be surprised to learn on p. 36, "If the stereographic projection is desired for a face belonging to a hexagonal or trigonal crystal, for which the indices are given according to the Miller or the Bravais system, it is necessary first to calculate the relative intercepts of the face on the three orthogonal axes".

These relatively trivial criticisms would be inappropriate in reviewing such a great work were it not that a second edition will almost certainly be called for soon. In conclusion, it would be fair to say that this book does for the subject of piezoelectricity what Voigt's "Lehrbuch" did for the whole subject of crystal physics. W. A. WOOSTER

WHAT CHEMISTRY OWES TO X-RAYS*

By Dr. KATHLEEN LONSDALE, F.R.S.

In the nineteenth century, the table of atomic weights and the periodic classification of the elements were obtained by classical chemical methods. In the twentieth century, X-ray methods have added to these, atomic numbers and atomic radii. The twin sciences of X-ray spectroscopy and X-ray crystallography were founded in 1912 by the famous von Laue experiment. By measuring the X-ray spectra of all the known elements from aluminium to gold, Moseley, in 1913, was able to show that each element could be assigned a number (not always in the order of the known atomic weights) which was later identified with the charge on the nucleus in the Rutherford–Bohr atom, or the number of extra-nuclear electrons in the neutral atom. But while the ideas of integral nuclear charge and of the *K*, *L*, *M*, etc., orbits of electrons were primarily due to investigations of X-ray spectra, the study of X-ray scattering by the rare gases has shown that the Bohr orbital model is inadequate, and has demonstrated the superiority of the Sommerfeld wave-mechanical model of the atom, with its statistical electron-density distribution and its range of energy states. Atomic structure is fundamental to chemistry.

X-ray spectroscopy and X-ray scattering combined have also given by far the most accurate value to date of Avogadro's number, $6{\cdot}0228 \pm 0{\cdot}0011 \times 10^{23}$, obtained by equating the wave-length of X-rays as measured with a ruled grating and with a crystal of known density and structure.

X-ray spectroscopy has provided analytical chemistry with a tool of great sensitiveness for the identification of individual elements, since each element gives a spectrum almost (although not quite) independent of its state of aggregation or of chemical combination, but in any case quite distinguishable from that of other elements. As little as 10^{-9} gm. of uranium can be detected by its X-ray spectrum. This X-ray method has led to the discovery and identification of new elements; some, like hafnium and rhenium, now isolated and accepted; others, like the natural element 93 (isotope of neptunium), detected by Mlle. Cauchois and her colleagues in certain tantalites and monazites, but still awaiting confirmation by other methods. The development of sensitive curved-crystal focusing spectrographs has enormously increased the possibilities of X-ray spectroscopy, which is not used in Great Britain as much as it should be, either in science or in industry.

The chemical action of X-rays is small but not unimportant. It is almost entirely due to direct ionization and to the production of further ionization and activation through photo-electrons. This is the case, for example, in the photographic action of X-rays, in the production of very pure water through the decomposition of organic impurity by prolonged irradiation, and in the action of X-rays on living tissue.

But the greatest debt owed by chemistry to X-rays comes from the fact that by means of X-ray crystallography the study of the constitution of matter has been extended to the solid state. One of the most important properties of the solid state is cohesion. It is a remarkable thing, but so familiar that we have ceased to wonder at it, that if we lift one end of a poker, which is a conglomerate of crystals, the other end comes up too. Newton remarked that it was the business of the philosopher to explain this property, which is not found in ordinary liquids or in gases, though liquids have a non-directed cohesion. We think of these directed, permanent forces as physical, but they are surely chemical too, for they are an essential part of the composition of the solid substance and are related to the nature of the chemical bonds between the atoms. Since the atoms are continually vibrating, the chemical bond is not even a static one, but is a constantly changing balance of attractive and repulsive forces. Ordinary methods of chemistry cannot be applied to the solid state, since dissolving, melting or vaporizing a substance destroys its solid character, and may completely change the molecular configuration or the nature of the inter-atomic bonds. The first X-ray crystal analyses by W. L. and W. H. Bragg heralded a new era in structural chemistry, an era in which the importance of atomic radii was first realized, although even now insufficiently realized by most chemists. It soon also became apparent that the former classification of bonds as being ionic or homopolar was entirely inadequate. Metallic and van der Waals bonds are chemical bonds, and bonds of intermediate character also exist. Moreover, X-ray analysis has shown that for many purposes structural architecture is of foremost importance, and exact chemical constitution a secondary refinement. These points will be illustrated by examples, although it is not always possible to separate them.

Chemists had thought of compounds, such as sodium chloride, as being formed by the combination of atoms of different kinds, one of which had lost an electron, the other having gained it, and the two together forming an ionic molecule. They could prove that the ions Na^+ and Cl^- exist in solution, but could only conjecture that they also occurred as such in the solid state. X-ray methods proved it; but showed at the same time that no individual molecule exists. The Na^+ ion in solid sodium chloride is surrounded octahedrally by six Cl^-, to none of which does it stand in any unique relationship. In losing an electron, the sodium atom, so to speak, sheds a skin, and then proceeds to surround itself by as many neighbours of the opposite sign as it can conveniently attract, bearing in mind their relative sizes and the mutual repulsion of the surrounding anions. The number of anions a cation succeeds in holding (its co-ordination number) depends mainly upon the cation to anion *radius ratio*. If the radius ratio is greater than 0·73 (that is, $\sqrt{3}-1$), there will probably be eight-fold (cubic) co-ordination, as in caesium chloride (CsCl). If it is between 0·73 and 0·41 (that is, $\sqrt{2}-1$), there will be six-fold (octahedral) co-ordination, as in sodium chloride (NaCl) or magnesium oxide (MgO). If it is less than 0·41 there will be four-fold (tetrahedral) co-ordination, as in beryllium oxide (BeO). The same principle may be illustrated in AX_2 compounds by the series calcium fluoride (CaF_2), with an 8 : 4 co-ordination ratio; magnesium fluoride (MgF_2), 6 : 3, and beryllium fluoride (BeF_2), 4 : 2; with decreasing cation size. Finite complex ions, such as CO_3^{2-} and $PtCl_6^{2-}$ can of course exist, but they obey similar structural rules. The relative unimportance of valency is nowhere more strikingly illustrated than in the random structures, such as $LiFeO_2$, where Li^+ and Fe^{3+} randomly occupy the cation positions in a rock-salt type of structure; or in the spinels, which may be either of the type AB_2O_4 (where the valencies $A + 2B$ add up to 8), or of the type $B(A, B)O_4$, in which A and B metal ions of different valencies randomly occupy equivalent positions. The actual existence of some compounds is dependent upon this size factor; $NaPO_3$ and Na_3PO_4 can both exist because P^{5+} is big enough to hold four O^{2-} ions around it; but N^{5+} is not, and therefore although $NaNO_3$ exists, Na_3NO_4 does not. Solid solution of one salt in another with which it is not isomorphous, for example, $MgCl_2$ in $LiCl$, can sometimes take place with formation of a *defect* structure, a structure in which there are vacant places. Here there must be considerable local disturbance of valency conditions. The fact that (in spite of the Law of Definite Proportions!) FeS may contain up to 55·5 atomic per cent, of sulphur atoms is also due to a defect of cations in the structure.

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* Summary of lectures delivered at the Royal Institution on December 5 and 12, 1946.

When atoms are joined together by covalent bonds, molecules do exist. In fact, they need not be finite, but may be infinite in one, two or three directions (for example, tellurium, antimony and diamond). Such infinite molecules were unknown before X-rays revealed them. The molecules are held together by van der Waals forces, or by hydrogen or hydroxyl bonds, or by a measure of polarization. Bonds of a kind intermediate between the extreme ionic and covalent types not only exist, but also are most common. In the silicates, for example, the Si—O bond has 50 per cent ionic character. The study of the silicates by W. L. Bragg and his colleagues has written a new chapter in chemical history; it has, as the president of the Royal Society said recently, "transformed a chemical riddle into a system of simple and elegant architecture". In cases such as aluminium fluoride (AlF_3) and silicon fluoride (SiF_4), where an abrupt change of melting-point has been taken to mean an abrupt change from ionic to covalent binding, what is really involved is a change from an infinite lattice (all similar bonds) to a lattice of finite molecules (with strong interatomic, but weak intermolecular, bonds), the change being governed entirely by considerations of size.

Definite intermetallic compounds exist, as well as solid solutions. Chemistry now has to cover the whole field of metals and alloys. Hume-Rothery has shown that structure type in many alloys depends not on valency or chemical formula, but on the ratio of the number of free electrons to the number of atoms. This rule may be only approximate, but there does seem to be a marked analogy between the structure of some metals and of some defect ionic-compounds. Sodium, for example, consists of a body-centred cubic arrangement of positive metal ions, with about an equal number of electrons, free or nearly free to move, giving high thermal and electrical conductivity. The α-form of silver iodide consists of a body-centred cubic arrangement of negative iodine ions, with an equal number of positive silver ions forming an interstitial liquid, and giving a high ionic conductivity. There seems no good reason why the bonds should be regarded as chemical in one structure and not in the other. Interstitial solid solutions of small atoms in metal structures (for example, hydrogen in zirconium, carbon in iron) are of great industrial importance. The difference between a mixture, a solid solution and a compound is easily observable by X-rays. Each element or compound gives its own X-ray patterns, by means of which it can be identified. (Note the difference between chemical analysis through X-ray spectroscopy, which identifies the elements in a substance; and X-ray crystallography, which identifies the substance itself by comparison with a set of standards.) A mixture gives the patterns of both constituents; a solid solution gives an intermediate pattern, from which the proportions of each constituent can be found with an accuracy of 1 or 2 per cent. A different type of chemical analysis was that in which, by measurement of the positions and intensities of the powder lines from long-chain ketones, Shearer in 1922 deduced the lengths of the chains and the positions of the ketonic oxygens.

In the field of organic chemistry, the size and shape of the molecule, the arrangement of atoms in it and the nature of the inter-atomic bonds have always been of particular interest to chemists. The diamond and graphite structures were among the first to be determined, but even now they are not fully understood. It is not certain whether there is a concentration or defect of electrons between neighbouring carbon atoms in diamond, and some X-ray reflexions from some diamonds are not accounted for. The usual graphite structure holds for about 80 per cent of all specimens, natural and artificial; but there are other ways in which the hexagonal layer molecules can be stacked together. Graphite-potassium 'alloys' can be formed by the holding of potassium atoms between the layers; another argument for regarding the van der Waals forces as essentially chemical in nature. X-rays can explain why charcoal can adsorb gases so easily as to act as a catalyst in bringing reacting gases together, and why its adsorption is much increased at low temperatures. The first property is a question of the increase of surface when graphite is in a colloidal state, the second is that of a reduction of atomic vibration which otherwise hinders the entry of foreign atoms. In graphite the valency bonds are intermediate between single and double bonds, having a bond order 4/3. The binding in the layer molecules may alternatively be described as metallic. Measurements of diamagnetic anisotropy confirm that the electron orbits in the layers have exceptionally large areas. The shape of the benzene nucleus and the nature of the aromatic bonds have also been determined unequivocally by X-ray methods, without the use of any assumptions. In fact X-ray analysis, and careful Fourier determinations of electron density contours in particular, have provided an immense amount of evidence for the theory of resonance, or mesomerism. In aromatic substances, such as coronene, and in conjugated systems, such as sorbic acid, the lengths of the C—C bonds have been related to the bond order; and improved methods of three-dimensional Fourier syntheses are enabling such measurements to be made in structures where atoms would not be properly resolved in an ordinary two-dimensional Fourier projection. In aliphatic long-chain compounds such as paraffins or fatty acids, the C—C bonds are similar to those in diamond, and the carbon atoms are arranged in a plane zigzag at nearly the tetrahedral angle; but investigation of the links of the chain in polythene (where the effect of end-groups can be neglected) has shown that besides a large thermal motion normal (but not parallel) to the chain-length, there is an actual sideways spreading of the electron cloud; an effect which is confirmed by diamagnetic measurements. X-rays can therefore provide evidence of electron-cloud distortion in molecule formation, as well as giving a measure of thermal vibration in different directions for the various atoms in a molecule.

Another important chemical problem upon which X-ray methods have given much information is that of hydrogen- and hydroxyl-bond formation. Although X-ray analysis cannot in general locate hydrogen atoms, because of their low scattering power, hydrogen bonds can be detected because of their reduced length as compared with van der Waals bonds. The effect of replacing hydrogen by deuterium has been studied, and also the configuration of water of crystallization and adsorbed water. Water layers, held in position by residual forces, can increase the layer spacing of clays from 10 to 20 A., and some protein structures also contain considerable amounts of water. Such structures form special cases of compounds in which two different molecules crystallize together. Picryl iodide (tetragonal) and hexamethylbenzene (triclinic) crystallize together to form an orthorhombic, pseudo-hexagonal layer structure. The suggestion, by Fraenkel and Rudall, that insect cuticles consist of alternating monolayers of protein and polysaccharide, promises a wide field of investigation.

Many natural fibres give good and characteristic X-ray patterns, from which the size and shape of the fundamental unit of structure (a link in a high-polymer chain) can be determined, and also the size, shape and arrangement of the fibre crystallites, or micelles. Cellulose and alginic acid, linear proteins such as the fibroin of silk and the keratin of birds and reptiles have been studied. Although the X-ray patterns are comparatively poor, it is a very striking fact that stretched and unstretched wool, hair and horn on one hand give patterns which, as Astbury has pointed out, are almost identical with those of stretched and unstretched myosin on the other. In spite of their very different chemical constitution, their structural architecture is similar (compare $NaCl$, MgO and Li_2TiO_3; or many of the silicates). The visibly crystalline proteins, such as insulin and hæmoglobin, also show definite similarities of intramolecular structure. X-rays have shown that some of the globular proteins are just polypeptide chains folded in different ways, and that when unfolded (denatured) they form linear fibrous proteins of about the same density. An artificial wool prepared from ground-nuts was the outcome of chemical research based on such deductions from X-ray data. The peculiar mechanical properties of rubber, which resemble those of animal tissues, are a consequence of its molecular configuration, and the differences between rubber (*cis*-) and gutta-percha (*trans*-), both high polymers of isoprene, are being studied by X-ray methods.

Bernal has summed up the different stages in X-ray investigation of complex substances as being (1) identification; (2) measurement of molecular weight; (3) measurement of molecular symmetry; (4) measurement of molecular size and shape; (5) determination of position of substituent groups; (6) of each atom; (7) and of the electron density distribution throughout the solid. One may add also the changes in atomic and electronic configuration that take place with change of pressure, temperature and time. In the analysis and synthesis of a complicated substance such as penicillin, X-rays can be, and have been, invaluable in identifying and checking up on degradation products and on synthetically produced material. Exact measurements of molecular weight (density multiplied by volume of unit cell multiplied by Avogadro's number divided by number of molecules in unit cell) by X-ray methods have been used to correct wrong chemical formulæ and to determine amounts of water of crystallization. Molecular symmetry can distinguish, for example, between *cis*- and *trans*-isomers. The study of sterol derivatives by Bernal showed that the size and shape found by X-rays was quite inconsistent with the then accepted stereochemical formula, and led directly to the present formula which has been confirmed by both chemical and X-ray measurements. Bernal was also able to suggest, even without a complete analysis, just where substituent groups must go in order to explain the double-layer formation in many sterols, and the single layers that occur in the sex hormones.

In order to determine atomic positions completely, it is necessary first to have sufficient X-ray measurements, and then to interpret them. The interpretation is sometimes simplified either by putting a heavy atom into the molecule, or by comparing isomorphous compounds, in one of which there is a fairly heavy atom. The first method gave the structure of platinum phthalocyanine and of $Fe(CNCH_3)_6.Cl_2.3H_2O$ very directly. It was also successfully used in the X-ray analysis of the two cholesteryl iodide structures by Carlyle and Crowfoot, although these were much more difficult because the heavy iodine atoms were not in special positions. The analysis of the structure of penicillin (Crowfoot and Rogers-Low; Bunn and Turner-Jones; to be published) was achieved by comparing the two isomorphous potassium and rubidium salts with the related, but not isomorphous, sodium salt. It represents the technique of X-ray analysis used at its fullest power, both in regard to difficulty of experimental manipulation and of reasoned interpretation. In the case of complex chemical substances such as these, X-ray and chemical methods go hand in hand, each owing much to the other.

Finally, it is possible, by means of X-rays, to study the thermal vibrations of atoms and molecules, movements which are influenced by, and which throw light upon, the nature of the chemical bond. The partial breakdown of crystalline forces that occurs when atomic groups begin to rotate, or when statistical structures are formed in which groups, by assuming random orientations, simulate a higher symmetry than they actually possess, must correspond to very peculiar conditions in the chemical bond. There are also crystals which, although regular enough to give good X-ray diffraction, behave in many respects like liquids. A study of these may help to bridge the difficult gap between relatively simple chemical compounds and the complex substances that constitute living matter.

THE TOTAL SOLAR ECLIPSE OF MAY 20, 1947

By Prof. F. J. M. STRATTON, O.B.E.

THE first total eclipse of the sun after the conclusion of the recent World War will take place on May 20 next. The belt of totality passes from Santiago in Chile, where the sun will rise in eclipse, across the Argentine, with Cordoba close to the edge of the belt, Paraguay and Brazil, leaving South

America at Salvador; it then crosses the Atlantic without touching any islands, enters West Africa just south of Monrovia in Liberia, runs through the Ivory and Gold Coasts, Nigeria, the Cameroons, French Equatorial Africa, the Belgian Congo, Uganda and Kenya, passes just south of Nairobi, and leaves the East African coast just north of Mombasa, the sun setting in eclipse. The width of the track varies from about 80 miles at sunset and sunrise to about 110 miles in Brazil and West Africa.

The Atlantic coastal regions crossed by the belt of totality are both very cloudy, wet areas in May, and the best chances of success for astronomical observations would seem to be provided by the high lands of Brazil, which can be reached by rail and air, north and north-west of Rio de Janeiro. One British expedition, under the leadership of Dr. J. A. Carroll, is going to Araxa; the other members of the party are Dr. Alan Hunter and Dr. Alan Baxter. Their programme consists of observations of chromospheric line-widths by means of an echelon spectrograph, a study by means of an objective interferometer of possible motions in and of the corona, and an examination of the darkening towards the sun's limb in the infra-red. It is expected that a party consisting of Mr. Michie and Mr. Ivan Thomsen, sent by the New Zealand Government, will join the British party; also a party of Australian radio-physicists, who will carry out a radio-noise programme.

The possibility of securing observations from the air in the West African zone has been carefully considered; but in view of the type of aircraft available and the heavily cloudy conditions expected, it was felt that there was no chance of improving on the spectrographic results obtained from the air in Canada in 1945.

Not much information has yet been received of other expeditions. The Saltsjöbaden Observatory in Sweden is sending two parties under the general supervision of Dr. Öhman, one to Brazil and one to West Africa. The main object of the double expedition is geodetic, to gain information on the shape of the earth by comparing carefully timed observations at the two stations. But it may be taken for granted that Dr. Öhman's presence indicates that part of the programme will be connected with the problems of the polarization of the coronal light.

It may be assumed that the Cordoba Observatory will organise an expedition, but no details have yet been received. The National Geographic Society and the U.S. Army Air Force are sending a joint expedition to Bocayuva in the State of Minas Geraes, about 400 miles north of Rio de Janeiro. The altitude of the sun will be about 40°, the duration of totality 3 min. 50 sec. The programme comprises coronal photographs, including colour photographs, polarization of coronal light, spectra of the flash and corona; the temperature of the corona near the limb will be studied and the Einstein relativity effect will be looked for, though the field of stars is not favourable for this purpose. Changes in the ionosphere at successive contacts will be watched, and during the eclipse *radio-sondes* will be sent up and the Air Force will fly observation aeroplanes equipped with instruments. The most important instruments will be taken to South America by air. Dr. Lyman J. Briggs, recently director of the U.S. National Bureau of Standards and now chairman of the Research Committee of the National Geographic Society, will lead the party. Fifteen observers, including Dr. van Biesbroeck and Dr. Weaver, will form the eclipse party and will come from the U.S. Naval Research Laboratory, the National Bureau of Standards, Georgetown Observatory, Washington, Yerkes Observatory and Lick Observatory.

The eclipse will be invisible in Europe, save as a partial eclipse in the extreme south of Spain.

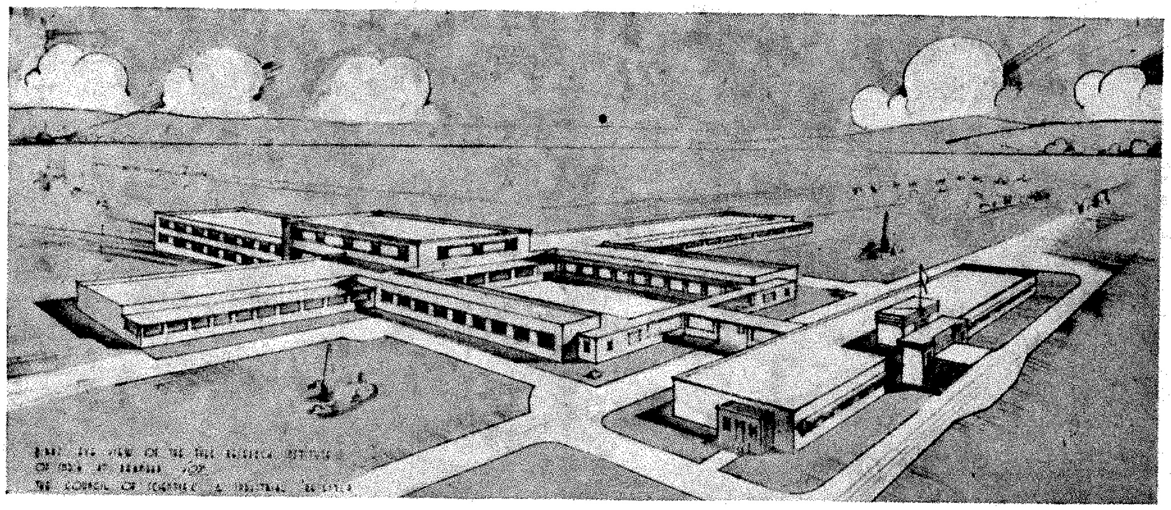
FUEL RESEARCH INSTITUTE OF INDIA

By Dr. J. W. WHITAKER
Director, Fuel Research Institute

THE Fuel Research Institute for India is being built in the Jharia Coalfield at Digwadih, some ten miles south of Dhanbad, and 170 miles north-west of Calcutta. The area of the site is 150 acres.

The work of the Institute will comprise technical investigations and research into the sampling, analysis and testing of fuels; combustion and furnaces; heat transference; coal carbonization; coal purification; briquetting; gasification; hydrocarbon synthesis and hydrogenation; tars and plastics; liquid fuels and internal combustion engine performance; smoke and atmospheric pollution. Fundamental research will not be neglected. Fuel technology, broadly speaking, is chemical engineering; it meets with the same problems in its field of action. Pure science is imperative: engineering technology is equally imperative, and economics must not be underrated.

India produces yearly about 25 million tons of coal valued at Rs. 30 crores at the pit-head. Her coal reserves have been estimated at some 65,000 million tons, but many seams are difficult to utilize economically. It is the main function of the Fuel Research Institute to ensure that this valuable supply of material be employed to the best advantage. At the same time, the properties and uses of all types of fuel will be studied, including petroleum, wood, charcoal, alcohol and gaseous fuels. There are, of course, a number of problems peculiar to Indian fuels. Thus in the coalfields of Bihar and Bengal, which are major coalfields, an important difference exists between Indian coals and those of Great Britain. In Britain most seams are relatively clean, or can be separated into clean and refuse bands. With Indian coals, however, the line of demarcation is seldom sharp. Frequently the clean coal has an ash content of 12–15 per cent or more—a feature attributable to the drift origin of the seams. These coals are difficult to purify by ordinary washing methods, a difficulty to be expected as the coal and foreign matter were originally deposited simultaneously as sediment from water. The coals in question are of the bituminous type, and many of the seams yield excellent coke with low sulphur content, in spite of the comparatively high content of ash. On the other hand, certain seams remain unworked because of still greater contamination with foreign matter. In other coalfields, for example, Assam, unusual difficulties are experienced because of abnormally high sulphur, present largely as organic sulphur and as sulphate. The ash content of these coals is low, the calorific value high; sulphur alone is the handicap.



ARCHITECT'S DRAWING OF THE FUEL RESEARCH INSTITUTE, INDIA

The problems of coal purification and processing are thus particularly important and require special attention.

Scope of Work

All departments of the Institute will co-operate in the conduct of schemes of research, but at the outset the following divisions are proposed: (1) Physical and Chemical Survey of coal resources (including field laboratories); (2) Carbonization and by-products (including colloids and rheology sections, tars and plastics); (3) Liquid Fuel Division (including hydrogenation, synthetic fuels, petroleum, alcohol, etc.); (4) Physics Division (including pyrometry, calorimetry, heat transference, X-ray and spectroscopy); (5) Gaseous Fuels Division (including combustion control); (6) Engineering Division (including preparation of coal for the market, boiler plant, etc.); (7) Library and Intelligence; (8) Administration and Office.

The present programme comprises a preliminary survey of the chief seams, including proximate and ultimate analyses, washability tests, ash analyses and tests, coking tests, carbonization assays, gasification tests, and investigations into tars. Subsequent work will include more detailed examination on the above lines and further researches into the utilization of the coals, either directly as fuels or indirectly as the products of carbonization, complete gasification, hydrogenation, and synthetic processes. Work will also be done on Indian oils and fuels not derived from coal, such as wood and alcohol. Pilot plant will be constructed as required.

Lay-out and Research Sections

It is expected that the construction and equipment of the laboratories and workshops will occupy two years. A third and fourth year will be devoted largely to the construction of plant. Broadly speaking, the lay-out is divisible into three main portions, namely, the administrative section, the laboratories and the technological block. Due to the climatic conditions, air-conditioning will be provided for the administrative and laboratory sections.

The General and Coal Survey Laboratories will include rooms for ash estimation, for ash fusion tests, and for research on refractories; inorganic chemical laboratories; rooms for high- and low-temperature assay, and coking and swelling tests; rooms for determination of moisture, volatile matter, carbon dioxide, etc., and for the ultimate analysis of coal; an inorganic analytical laboratory for determination of sulphur, phosphorus, arsenic, chlorine, etc.; calorimetry and balance rooms; preparation and solution rooms, and a small office.

For carbonization, by-products and liquid fuels the lay-out comprises a laboratory for special carbonization experiments; a routine laboratory for carbonization, blending and oxidation tests; an organic laboratory for work on liquid fuels; a physical chemistry laboratory for work on mineral oils and the like; preparation and balance rooms, and a small office.

In the Physical and Gas Research Subsections, rooms will be provided for X-ray control; pyrometer testing, ultra-violet and infra-red spectroscopy; gas analysis; combustion and gas research; a special gas research laboratory for fractionation of gases, thermal investigations, etc.; and a preparation room and office.

For special research, provision has been made for work in microscopy, coal petrography and related investigations; section-cutting and polishing; hydrogenation; rheological investigations and particle-size determination; research on colloidal fuels; electrical, magnetic and optical properties; chromatography and photo-chemical analysis; microanalysis, molecular research; hydrocarbon synthesis, and plastics research.

For coal preparation, equipment will be installed for making standard tests on the washability of coals. In addition, accommodation and apparatus will be provided for tests on commercial samples; and for special researches on methods of de-ashing of Indian coals, for example, by froth flotation. Rooms are also allocated for investigations into wetting and frothing and amalgamation agents with and without fine grinding, and for investigations into slurry problems in washeries, the stabilization and coal-cleaning media, etc. These laboratories will be near the technological block, within easy access of sampling, crushing and screening plants.

The Technological Block

The technological block will have the following facilities: (1) weighing, crushing, grinding, and sampling plant, and fine-grinding equipment; shatter test apparatus for coke; abrasion test apparatus for coke; screens; a room for the storage of samples for reference; (2) general stores; precision instrument shop; (3) general workshops; (4) room for electrical power distribution; (5) semi-technical carbonization ovens; (6) small gasification, hydrogenation and artificial oxidation plant; (7) boiler and pulverized fuel firing equipment; (8) vibrator screens for screen analysis on large-scale samples; and (9) small foundry.

Space is provided for boiler and other plant which may be required, for example, coke ovens, producer gas units, hydrogen generators, low-temperature carbonization plant, tar-hydrogenation plant, refineries, gas holders, Fischer–Tropsch units, and coal-washing plant.

A railway siding will be available for the technological block and the above plants in due course. Meanwhile, permission has been obtained to use the nearby railway siding of the Tata Iron and Steel Co.

Coal Survey Laboratories

To take stock of the basic supplies of fuel in India is but plain sense. Fuels provide the raw materials for heating and power generation and for numerous chemical industries, which in a planned economy require a degree of co-ordination. Fuels are essential to industries producing dyes, explosives, drugs, plastics, disinfectants and antiseptics; coal tars are of prime importance in highway construction; while in the manufacture of lime and cement, of bricks and refractories, of iron and steel, fuels are indispensable. Add to this that they provide usually the main source of power for all industries—generally through the medium of steam-raising plant—and their fundamental importance is unquestionable. Fuels, however, are a wasting or diminishing asset in contrast to water-power. Consequently reserves become of great significance. In India reserves of good coking coal are disconcertingly low, according to present statistics, reserves of iron ore of excellent quality being far in excess of the known available supplies of coal suitable for the manufacture of the requisite metallurgical coke. A policy of conservation for such coals may have to be adopted.

It is thus necessary at the outset to make a survey of the types of coal and the amounts available, and it is proposed to establish, as in Great Britain, coal survey laboratories in the major coalfields, staffed and equipped for the sampling and testing of fuels. Standard methods will be adopted wherever practicable. It is not the intention, however, to confine the functions of these laboratories to the assessment of resources, qualitative and quantitative. They will be encouraged to help in the numerous problems which arise in industry, whether fuel-producing or fuel-consuming. Moreover, should national policy so decide, these stations may also serve in the control of distribution and utilization of fuel. Meanwhile, their main function is the physical and chemical survey of the fuels available. Needless to say, in this work the Fuel Research Institute will co-operate closely with the Geological Survey and the Mines Department. The coal survey for the Jharia Coalfield will form part of the work of the Institute. The officers of the various survey stations will be trained at the Institute, and close liaison maintained between them and headquarters by such means as half-yearly conferences.

Staffing and Expenditure

The technical, administrative and artisan staff at the Institute will number between 100 and 200. The administrative staff will be of the order of 20–30; the technical staff will have 15–20 senior officers with 40–50 juniors, and an equal number of laboratory assistants and mechanics. Adequate unskilled labour has also been allowed for. Each of the field survey stations will carry a staff consisting of one or two senior officers, with 5–10 juniors, and a proportionate number of assistants for office and laboratory work. In some cases, unusually heavy charges have had to be anticipated for accommodation, transport, apparatus and chemicals, especially if the stations are remote from towns.

The annual expenditure of the Fuel Research Institute will be of the order of £100,000, excluding the expenditure on the field survey stations, which will vary with their number, but is expected to be of the order of £5,000 each. The capital cost of the central Institute and of the survey stations is of the same order as the annual expenditure, say £120,000 for the main Institute and £7,000 for a survey station.

The foundation stone of the Fuel Research Institute was laid by the Hon. Mr. C. H. Bhabha, Minister for Works, Mines and Power in the Interim National Government, on November 17, 1946.

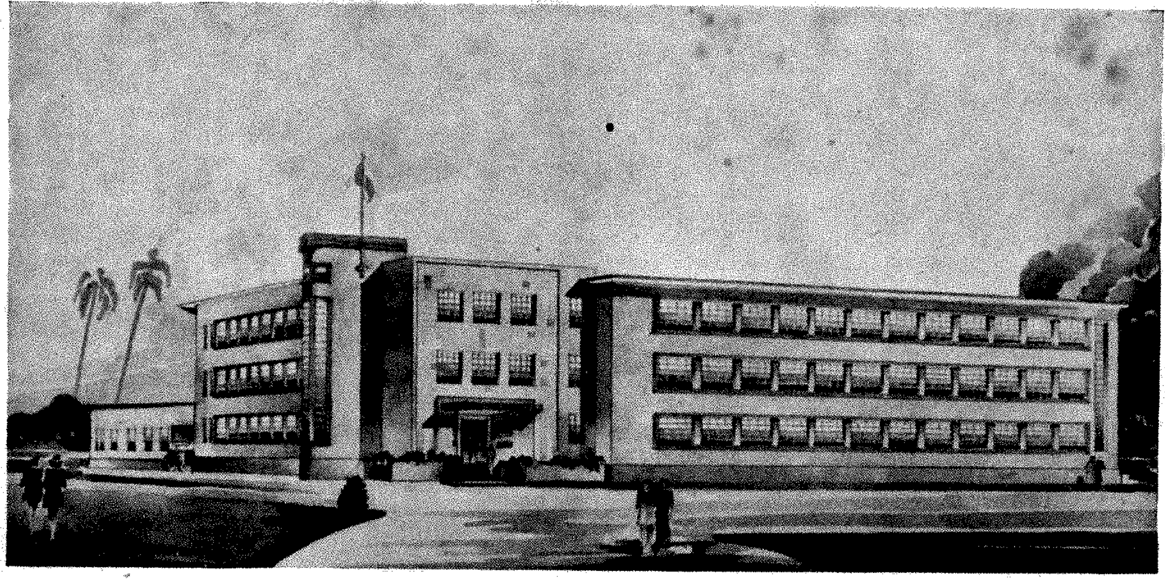
CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE, INDIA

By Y. P. VARSHNEY

Acting Officer-in-Charge, Central Glass and Ceramics Institute

THERE are few fields of industrial development in which scientific investigation has played, during the last twenty-five or thirty years, such a decisive part as in the glass and ceramic industries. Whereas in these industries spectacular developments have taken place in the industrially advanced countries of Europe and in America, conditions in India have remained comparatively static, although under the stress of war there has been some expansion.

Attention was directed to the unsatisfactory condition of the Indian glass industry and to the need for an Institute for training and research in glass technology by the Indian Industrial Commission so early as 1918, and this was further stressed in the report of the Indian Tariff Board on the glass industry in 1932. It was considered that the industry in India could not be expected to make satisfactory progress or make much headway without the aid of properly organised technological institutions, although the industry enjoys numerous advantages such as availability of raw materials, labour and a ready market within the country. The need for research was never felt so keenly both by the Government and the industry as during the War, when large and immediate supplies of glass and ceramic goods were required, and the Indian industry was hard put to meet the



ARCHITECT'S DRAWING OF THE CENTRAL GLASS AND CERAMIC RESEARCH INSTITUTE, INDIA

demand in respect of quantity and quality, as well as of variety. It was to fulfil this urgent need and to create an organisation for helping the glass and ceramic industries in the application of scientific methods that the Government of India, through the Council of Scientific and Industrial Research, decided to establish the Central Glass and Ceramic Research Institute.

The preliminary details for its establishment were worked out by a committee under the chairmanship of Sir S. S. Bhatnagar. A report embodying its proposals was submitted by the committee to the governing body of the Council in August 1944, and on the basis of its recommendations the Council decided (*a*) that the Institute be located at Calcutta, which is an important centre of glass and ceramic industries in India, and which offers many other advantages for the work and growth of an institution of this nature, and (*b*) that a sum of twelve lacs of rupees be provided for the capital expenditure of the Institute.

Site and Buildings

The site selected for the Institute is in one of the southern suburbs of Calcutta in comparatively quiet and open surroundings. It measures approximately 650 ft. × 440 ft., the shorter side on the west giving the road frontage; it is nearly seven acres in area. The major part of this plot is expected to be taken up by the Institute buildings, but a small portion may be utilized for building residential quarters for some of the senior staff, if this is considered necessary at a later stage.

The buildings of the Institute have been designed in an L-shaped plan and will consist of two sections, namely, a main building which is ultimately intended to be a three-storeyed structure, although only two storeys may be built at present; and the technological block, which is single-storeyed and has, for the greater part, a north-light roof.

Such a division was considered desirable in order that laboratories for precision work, library, museum, offices, etc., could be located in the main building, while furnaces, workshop, machines for raw material treatment, etc., and large testing units, the operation of which is of necessity attended by considerable vibrations and noise, could be placed in the technological block. However, these two sections, though distinct, are to be close together and connected so as not to hamper in any way the progress of co-ordinated operations being simultaneously carried out in both of them.

The main building, with a floor area of about 17,500 sq. ft. on each floor, will form the shorter arm of the L-design about 230 ft. long facing the roadway, as also the first 145 ft. of the longer arm which extends to a total length of nearly 325 ft. The remaining 180 ft. length of the longer arm is occupied by the technological block, which has a covered floor area of about 16,000 sq. ft. The main entrance will be on the outside of the corner of the L, facing the roadway.

On the ground floor of the main building, three spacious museum rooms will form the major part of the frontage. By the side of these will be a drawing office and blue-print room; while facing them across a central corridor which runs the whole length of the L will be the physical and physico-chemical laboratories, in which spectroscopic, spectrophotometric, X-ray and other equipment for the study of physical properties will be housed. Other rooms on the same floor will include a room for optical testing and instruments, electrical laboratories, laboratory for enamelling and decorative work, a constant-temperature room and a dark room for photographic and spectrographic work. On the first floor, directly above the museum rooms, will be the conference room, library and the lecture hall; there will be sitting-rooms for officers above the main entrance. Facing the library and lecture hall across the corridor will be the chemical laboratories, and in the other wing on this floor there will be a room for petrographic and microscopic work, and also three rooms for office, records and statistics.

The construction of the technological block was started in September 1945 and is now nearing completion. The installation of services is in progress. This block contains a maintenance workshop, a clay-working laboratory, refractories laboratory in which units for spalling tests, underload tests and P.C.E. values of refractory material will be accommodated; a room for treatment of raw materials such as crushing, grinding, grading, etc., and a large furnace room in which a number of experimental furnace units are to be housed.

In choosing the L-shaped design, particular consideration has been given to the possibility of future expansion, and both the main building and the technological block are capable of considerable expansion independently without detracting from the architectural harmony of the entire structure. Besides, due attention has been given to adequate lighting and ventilation, ease of movement and communication inside the building, as well as suitability to local weather conditions. It is proposed that the main building shall be air-conditioned.

In view of the developments in fittings and devices used in laboratory services and of the great importance of such services in a laboratory, much attention is being given to this feature. Besides an adequate water supply, the Institute laboratories will have town gas supply, A.C. and D.C. electric supply and service lines for compressed air and vacuum according to requirements.

Functions

The functions of institutions concerned with technological subjects are objective in character, namely, the improvement and development of the particular industry or industries with which they are connected. This forms the chief objective of the Institute, and in keeping with it greater emphasis will be laid on industrial research and development of glass and ceramic processes. However, it is to be borne in mind that fundamental research has also to be promoted and encouraged, as without advancement in fundamental knowledge, no new industrial work of importance will be possible. Thus the Institute will aim at fundamental research having a bearing on different branches of glass and ceramics.

To attain its objective of helping the growth and development of the glass and ceramic industries, the Institute must engage in activities of a diverse character. In a country like India, where the number of technically trained persons engaged in industries is very small, and knowledge about many of the methods of manufacture followed nowadays abroad is either completely lacking or scanty, an institution which can give technical assistance to the industry can serve a very useful purpose. To give such technical assistance will, therefore, be one of the immediate functions of the Institute. This will be directed largely towards improvement of the existing technique of manufacture followed in Indian factories, as well as helping in the adoption of manufacturing processes which have so far not been undertaken in India. Such technical assistance is expected to be largely confined to the early stages, until the progress of these industries encourages the growth of independent consulting technologists and agencies; and as these grow, the Institute will curtail this aspect of its activities. To promote the above aim, the Institute will also undertake the collection of data and dissemination of information by means of publications, discussions, lectures and visits of technical personnel to industrial works.

Training of technologists is another important function which the Institute will perform; but as there are other institutions in the country which have courses for training students in glass and ceramic technology, it is not intended to duplicate their work. The training given under the auspices of the Institute will therefore be confined to a few students who will be provided with facilities to acquire practical experience in the application of scientific methods to the solution of industrial problems, so that they may be able to take independent charge of technological duties in glass and ceramic factories.

Another function of the Institute will be to serve as a central organisation for the testing, grading and standardization of glass and ceramic raw materials and finished articles. This will include calibration of appliances and control instruments. As yet, there is no organisation in the country to carry out work of this nature. The Indian glass and ceramic industries have no specifications for raw materials or finished goods; and it is difficult to expect that specifications followed abroad can be strictly applied to present-day Indian conditions. It is felt that certain standards suitable to Indian conditions should be laid down, and the Institute will help in formulating them and revising them from time to time as the industry progresses.

In the majority of investigations undertaken at the Institute, it is expected that laboratory-scale experiments will suffice; but as the translation of laboratory results into commercial operations often involves aspects not covered by laboratory work, the Institute will carry out investigations on a pilot-plant scale. In this work it is expected that assistance from industrial concerns situated in Calcutta will be readily available.

To fulfil its purpose, it is scarcely necessary to stress the importance of the Institute maintaining the closest relations with the industries in India. Also, being a central organisation engaged in glass and ceramic technological work, it will keep in contact with similar organisations abroad.

Staff

The wide and exacting functions of the Institute demand that the directing staff, apart from possessing high scientific abilities, should be able to inspire a spirit of team-work and create an enthusiasm for it, and the Council is fully alive to these requirements. Although ultimately the Institute will have separate sections for glass, porcelain, enamels and refractories, during the period of organisation it will function largely on a composite basis; and it is rather early to say, at this stage, what will be the full complement of technical or other staff; but it is hoped that in the final stages the senior technical staff of the Institute will consist of a director in charge of the Institute with two assistant directors and three research officers specialized in different branches. To assist them there will be five junior research officers and a number of research assistants and research students. In the appointment of the staff, care will be taken to ensure that all branches of glass and ceramic technology are well represented, so that investigations on all aspects can be successfully conducted by those qualified for the work.

The foundation stone of the Central Glass and Ceramic Research Institute was laid by the Hon. Sir Ardeshir Dalal, Member for Planning and Development, Viceroy's Executive Council, on December 24, 1945.

SECRETION OF RED BLOOD CORPUSCLES

By Dr. FREDERIC DURAN-JORDA
Director of the Pathology Department, Ancoats Hospital, Manchester 4

STUDYING the problem of hæmopoiesis, we arrived at the conclusion that the red blood corpuscle was a product of secretion by a monoglandular cell, which, when present in the peripheral blood, has been classified as a polymorph eosinophil[1]. At that time, however, we were unable to demonstrate fully how this red blood corpuscle secretion could be seen objectively by research workers.

Since then, however, we have been able to see this red blood corpuscle secretion clearly in the hæmorrhagic cysts present in some thyroid glands, and also to appreciate its significance by using similar methods to those we have previously described in the study of fat secretion in milk and pus formation[2].

The process of hæmopoiesis in mammals takes place in two stages, which can both be studied objectively.

The first stage is the formation of the granules in the cytoplasm of the cell, which will become preformed red blood corpuscles. This phenomenon takes place in man in the stomach and intestines, and can be examined easily in the abomasum of the Herbivora, cattle and sheep[3].

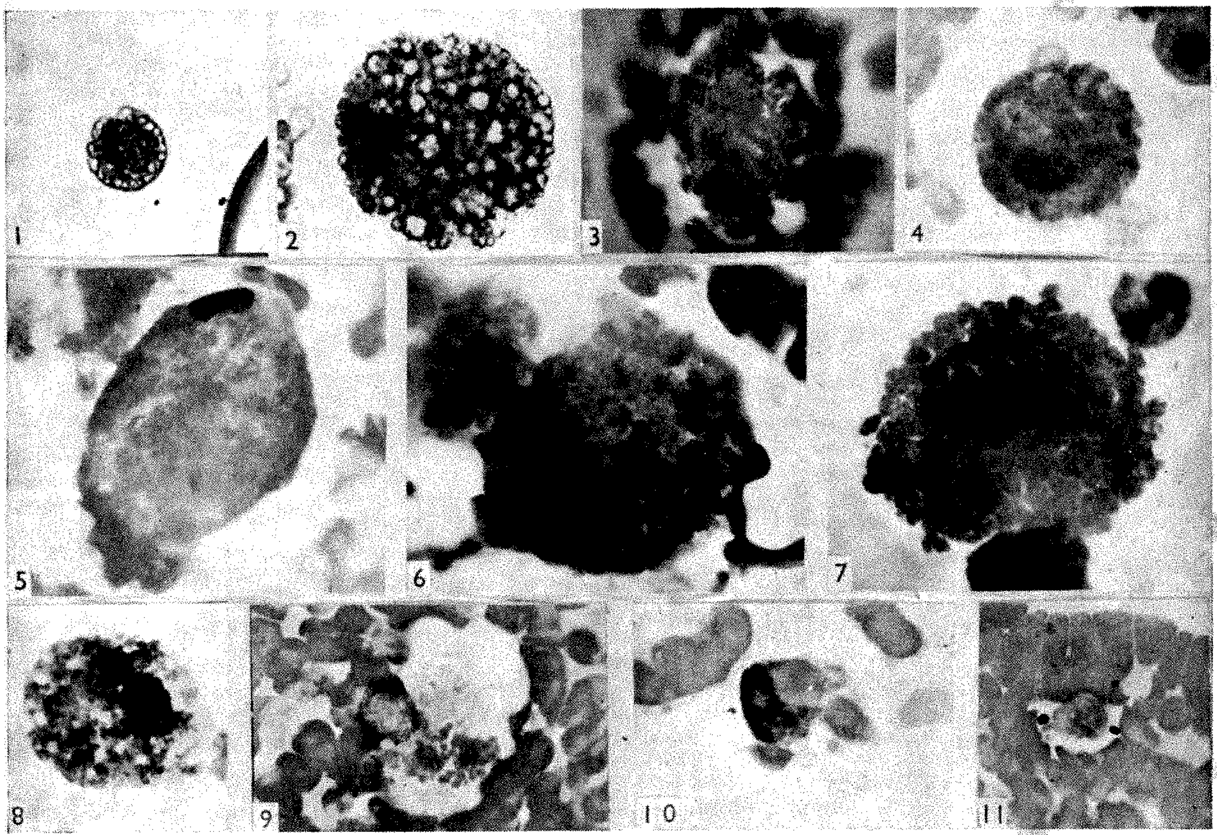
The second stage, the secretory one, is the stage by which the cell, from the aspect of a polymorph eosinophil, develops into a cell of a very large size, which eventually, after expelling the red blood corpuscles, shrinks and becomes a lymphocyte.

The hæmorrhagic cysts present in some thyroid glands were punctured immediately after thyroidectomy, using a capillary pipette which filled spontaneously with hæmorrhagic fluid. Part of this fluid was mixed with saline solution containing 1 per cent of 3·8 per cent sodium citrate solution, and added to the mixture were a few drops of methylene blue. The remainder of the contents of the capillary pipette were made into dry smears, which were stained with May–Grunwald Giemsa. In the wet films, we found that we could divide the cellular contents into three groups, as we had observed in the study of milk and pus.

(1) The first group was formed by what appeared to be polymorphonuclears which had a cytoplasm full of lipoid droplets with the same appearance as eosinophils in wet films (Fig. 1).

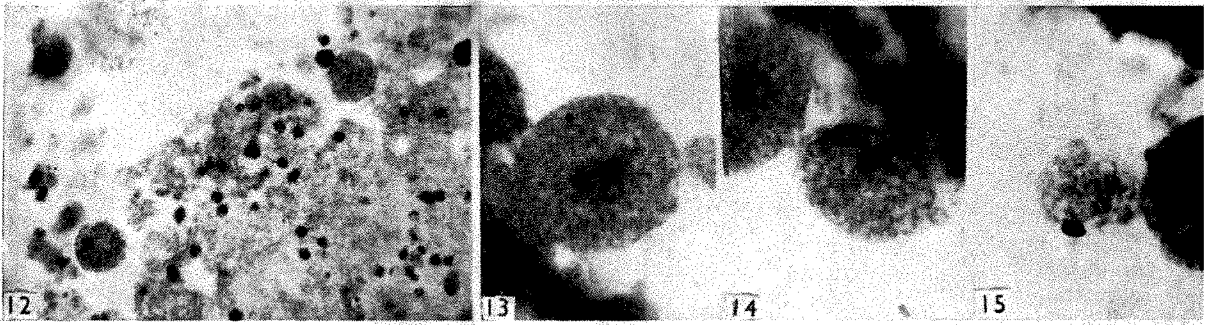
(2) The second group consisted of mononuclears which attained a tremendous size of more than 40 μ in diameter, and contained lipoid droplets in their cytoplasm, which were more homogeneous in size than those found in our previous studies of milk and pus cells, and reached a maximum size corresponding to a red blood corpuscle (Fig. 2).

(3) The third group consisted of smaller mononuclears which contained a fewer number of droplets



Smears stained with May–Grunwald Giemsa

1 and 2, Wet films of thyroid fluid, showing one cell with the aspect of a polymorph eosinophil, and another cell in full development; 3, polymorph eosinophil containing very large granules; 4, a mononuclear containing granules of eosin-like small red blood corpuscles; 5, a mononuclear with a nucleus compressed against the edge of the cell; 6 and 7, large cells filled with about 200 red blood corpuscles; 8 a cell in the process of shrinking and expelling red blood corpuscles; 9, a cell after shrinking which still contains granules of eosin; 10, lymphocyte showing a double feature—a lymphocytic nucleus and a fully developed red blood corpuscle (notice that the lymphocyte still contains some granules of eosin); 11 lymphocyte with one granule of eosin.



SECTIONS STAINED WITH HÆMATOXYLIN AND EOSIN

12, Section from intra-acinar hæmorrhage in a thyroid (notice cells of different sizes containing red blood corpuscles); 13 and 14, high magnification of two cells full of red blood corpuscles; 15, a cell in the process of expelling red blood corpuscles and shrinking.

and occasionally red blood corpuscles. Some of the cells were like a lymphocyte with a cytoplasm still containing a few lipoid granules.

Studying the dry, stained films, the evolution of the cells could be easily observed, as in this case the material which the cell contained was not dissolved by the alcohol used in the stain, and we could, therefore, follow the evolution of the cells easily in all the intermediary stages.

Again, our findings could be classified into three groups of cells.

(1) The group formed by different sizes of polymorph eosinophils which contained granules varying from normal eosinophil granules to very tiny red blood corpuscles (Fig. 3).

(2) In the second group, there was a range of mononuclears growing to a gigantic size, and, taking into consideration the normal size of one red blood corpuscle and the diameter of the large cells, which was approximately 40 μ, we could estimate roughly that the largest cells must contain about two hundred red blood corpuscles. All the space in the cytoplasm of the cell was occupied by red blood corpuscles, and in some cases it could be seen how the nucleus was pressed against the periphery of the cell (Figs. 4–8).

(3) This group consisted of small mononuclears, some of them having the typical appearance of a lymphocyte; in which case it could be seen that the lymphocyte still contained eosinophil granules in the cytoplasm, or occasionally a cell showed a double feature, namely, a lymphocytic nucleus together with a red blood corpuscle, all surrounded by a small halo of cytoplasm (Figs. 9–11).

These previous observations can be confirmed by studying some sections of thyroid which show intra-acinar hæmorrhage, in which case it is also possible to study these three different ranges of cells as found in the fluid from hæmorrhagic cysts (Figs. 12–15).

Studying the cells by micro-incineration, we could demonstrate that the lipoid droplets contained in the cytoplasm of the cells leave similar ash to the ash deposited by the red blood corpuscles.

If we accept that the red blood corpuscle is a product of secretion, the basis of hæmatology as it is at present understood will be changed, and there are some facts concerning this which should be discussed.

Biologists are able to study in different tissues cells which contain in their cytoplasm a small quantity of red blood corpuscles, and they have interpreted this as a phenomenon of phagocytosis; but if a cell contains about two hundred red blood corpuscles, which completely fill its cytoplasm, there is no room left for their digestion.

It is very surprising to find that our observations of red blood corpuscle formation and secretion by a monoglandular cell are similar to the observations made by Kolliker in 1854[4]; Kolliker describes how cells which contained in their cytoplasm a large quantity of red blood corpuscles shrunk until they became a small granulated cell (? eosinophil). Kolliker, therefore, saw the same thing we have described, but did not interpret it in the same way.

If the life of the red blood corpuscle is a hundred days, the daily development of approximately 250 polymorph eosinophils per cub. mm. will be enough to make good the wear and tear of the red blood corpuscles. This is more understandable than the actually accepted theory that the 5,000 normoblasts per cub. mm. present in a normal bone marrow, which is one third of the volume of the whole blood, should produce daily 150,000 red blood corpuscles, a rate of thirty mitotic divisions per cell in twenty-four hours. This fact in itself is quite extraordinary; but it becomes even more so when it is supported by a process of maturation and denucleation, this latter being so mysterious that it is still under discussion as to whether it takes place by a mechanism of nuclear expulsion or by one of karyorrhexis of the nucleus.

I should like to thank Prof. Wood Jones for his interesting and helpful discussions concerning this work. Also the surgeons of Ancoats Hospital for their kind co-operation with surgical specimens, and Mr. J. B. Dean for his assistance with the photomicrographs.

Conclusions

It is suggested that to study objectively the process of red blood corpuscle secretion in man, the hæmatic fluid from hæmorrhagic cysts present in some thyroids should be used, and the following conclusions have been arrived at.

(1) That the polymorph eosinophil is the carrier of pre-formed red blood corpuscles.

(2) That the polymorph eosinophil, by increasing its size and developing its granules, reaches the stage of a cell which has a cytoplasm containing about two hundred red blood corpuscles.

(3) The cell, after expelling the red blood corpuscles, shrinks and becomes a lymphocyte.

(4) This cycle of monoglandular red blood corpuscle secretion follows the same biological steps as the similar monoglandular processes which take place in the secretion of fat milk, and pus formation.

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[1] Duran-Jorda, F., *Lancet*, 186 (August 14, 1943).

[2] Duran-Jorda, F., *Nature*, **154**, 704 (1944); **156**, 110 (1945).

[3] Duran-Jorda, F., *Vet. J.*, **101**, No. 9, 191 (1945).

[4] Kolliker, "Human Histology", vol. 2 (1854).

SCRUB TYPHUS AS A STUDY IN ECOLOGY*

By Lieut.-Colonel J. R. AUDY, R.A.M.C.

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MITE-BORNE scrub typhus (tsutsugamushi disease) was a serious military problem in the Japanese campaign, and units unlucky enough to strike endemic foci suffered heavily[1]. The epidemiology of the disease was investigated in North Burma by the U.S. Typhus Commission, and in the Imphal area (Manipur, Assam) by a team based on the Scrub Typhus Research Laboratory, which attempted to do complementary work, particularly on the ecology of the disease.

The general findings of this team are shortly to be published, but this present note concerns an interesting aspect of its investigations, namely, the way in which light may be thrown on the ecology and behaviour of small mammals by a study of their infestation by Trombiculid mites.

This is possible because the Trombiculid mites are partly soil-bound: the non-parasitic nymphal and adult stages spend their lives in the soil, while the larvæ alone parasitize warm-blooded animals. The larvæ feed but once before returning to the soil for metamorphosis, the feed lasting from four days to several weeks according to the species. These mites have actually to be introduced to suitable foci, and will continue to infest such foci only if hosts pick up larvæ and return a proportion to the same place, thus maintaining a mite–mammal–mite cycle related to a patch of ground which may be far from the actual nest of the mammal. These mites are not conspicuous within or around rat-burrows, but appear to be liberated and picked up around feeding-places. There is a close parallel between these mites and the jigger flea *Tunga penetrans*, the larvæ of which are soil-bound while the female adults attack man.

Even though the larvæ can move quickly when stimulated, the range of movement of both larvæ and adults appears to be greatly limited, so that a heavily infested spot may adjoin an almost mite-free area a yard or two away. It is clear that such a parasite can serve as an ecological label, especially if its distribution is restricted or if the non-parasitic phase makes ecological demands of its own on the soil, which appears to be the case to a varying degree with different species.

The species most closely studied was *Trombicula deliensis* Walch, the vector of scrub typhus, while, for numerical as well as other reasons, the most important host for this and most other Trombiculids was *Rattus rattus* in its local varieties. An investigation of the distribution, population, and rate of turnover (namely, the number of larvæ becoming attached to rats daily, related to the short time, 3–5 days, spent on the host) indicates with little doubt that this species is the most successful Trombiculid ectoparasite of rats in the whole of the Far East. It is very closely related to *T. akamushi*, which shares part of its distribution in Malaya, New Guinea and the Philippines, and is the classical vector of tsutsugamushi in Japan.

That Trombiculid mites occur in 'islands' related to a restricted range of the principal host was illustrated several times, but particularly while trapping in a series of plots 50 yd. × 50 yd. in a strip transecting a large expanse of scrub near Imphal during December–January 1946, when 109 rats were caught. For the first 400 yards, 32/50 of the infested rats (*Rattus rattus* var.) caught carried apparently pure cultures of *Ascoschöngastia mutabilis* Gater, 1932, while a few were infested by this species mixed with a congeneric but distinct species, *A. kohlsi* Philip and Woodward, 1946, and only one rat with *A. kohlsi* alone. For the next 200 yards, 27/36 (75 per cent) were infested by a mixture of both species, while for the last 150 yards to the end of the transect, 20/23 (87 per cent) were infested by pure cultures of *A. kohlsi*, and not one by *A. mutabilis* alone. The existence of two such 'islands' of infestation by these two species, overlapping for less than 200 yards, is in this particular instance explicable by the restricted range of the rats in the rank scrub. The two species concerned remain attached to rats for a week or more: they are picked up and, after that time, dropped on to the ground near by. This restriction of range was illustrated in this same area by the trapping on two occasions of a grey rat (at present unnamed) which could be distinguished from the common species: in one of the plots, six of the eight rats caught were grey, and were all trapped within a circle of 30 yd. diameter, while near by three rats of the same grey species were caught one day in three adjacent traps.

It will be understood that these two overlapping 'islands' of infestation are not a picture of a permanent state, but of a stage in a dynamic situation. The rate at which the zone of overlap expands in both directions depends particularly upon the range of movement of the rats.

There are many examples of differential infestation of rats in contiguous areas. Gater[2] noted that two common Malayan mites, *T. munda* and *Gahrliepia fletcheri*, appear to be more common in villages than elsewhere. We found an undescribed species of *Schöngastiella* to have a similar distribution. Rats (239 *R. rattus* var. in October–November 1945) were trapped in Mongjam village near Imphal, and 87 per cent were infested by this species, while of these 44 per cent were 'pure cultures', showing that nearly half the rats were exposed to fairly uncontaminated 'islands' of infestation by this species. The infestation of these village rats by *T. deliensis* was 40 per cent, only 17 per cent of these being pure cultures. This contrasted with the findings in rats of the same species trapped in hill-foot scrub a few hundred yards away across a belt of rice-fields, where only 30 per cent were infested by *Schöngastiella* (26 per cent pure cultures), and 90 per cent by *T. deliensis* (64 per cent pure cultures). It is likely that the considerable evacuation of the village by the natives, which coincided with the establishment of military camps in the hill-foot area in 1942–43, led to a migration of a number of rats from the village to the camps, and to the seeding out of many colonies of *Schöngastiella*. This species remains attached to its host for a month or more.

The influence on the mites of the high rat population which frequented the scrub immediately on the edge of a camp was investigated by laying down lines of rats in small cages and counting and identifying the mites which they picked up in twenty-four hours. It was found that there was a rapid and significant increase in mite population as the immediate perimeter of the camp was approached.

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* Published by permission of the Army Medical Directorate, War Office.

A similar investigation transecting the junction between grassy scrub and a strip of forest following a water-course showed a significant and high population of mites in the narrow intermediate belt of dense vegetation between open scrub and forest. Such ecotones have repeatedly been associated with scrub typhus: we have been calling them 'fringe-habitats', and including hedgerows as a special case within this category.

The seasonal changes in vegetation were found to be considerable, to be related to seasonal variations in behaviour and population of the rats, and to be very intricate. Even so, some useful light was thrown on this complex picture by a study of the infestation of the rats, although the following discussion is intended to suggest ways in which this can be done and not to present a picture of what was actually happening in the Imphal area, where our investigations were very greatly limited and, in ignorance, not properly designed to this end.

T. deliensis, like *T. akamushi*, is a seasonal mite, in that the larvæ become very scanty during the dry season, whereas they appear in great numbers shortly after the onset of the rains. The 1945–46 inter-monsoon period in Imphal was unusually dry; but even so, at its height larvæ of *T. deliensis* could always be recovered from foci on seepages or by perennial streams which were kept moist by ground water, while they had almost completely disappeared from exposed dry sites. At such a time, it is possible to use this species in selected areas as an index of the host behaviour in relation to water-points, as well as an indicator of the behaviour of the hosts during the different seasons. This, however, needs very extensive collections: only one application appears to be worth while with the Imphal material, and that is to group the rats according to intensity of infestation (0, 0–10, 10–50, 50–100, 100–200, and more than 200 mites per rat), and to study the frequency of distribution of the rats within these groups month by month, in conjunction with the rate and average intensity of infestation. As this can be done only with pure cultures of the species, *T. deliensis*, being investigated, it is clear that we are dealing with a selected sample of rats exposed on fairly uncontaminated '*deliensis* islands'. This study shows that with the first flood of larvæ which appeared after the rains broke in May 1945 there was a very high rate of infestation (more than 70 per cent) but a relatively low intensity, most of the rats being in the 10–50 mites-per-rat group. Two or three months later, there was a distinct shift in distribution from the low-intensity groups to the highest. At the height of the following dry season, the rate of infestation fell from more than 60 per cent to less than 10 per cent, and particularly the lowest and the highest intensity groups were represented. This *suggests* either an initially dispersed appearance of larval mites, or a wide and variable range of movement of the rats, or more probably both, followed later probably by a second generation of larvæ in more compact conditions of association between mite and rat. Later still, the larvæ were scarce and a few rats remained heavily infested because they were in moist foci where the larval population was being maintained.

All these findings have a bearing on the ecology of scrub typhus itself. The disease is very sharply localized, and has an ecology of its own, which is related to vegetation and terrain but not directly to any specific plant, although most of the typhus appears to reside in rank grassy undergrowth, on waste-land or water-meadows, or in the fringe-habitats at the edge of such tracts.

It is considered that a planned study of the Trombiculids infesting rodents and shrews, as well as the other ectoparasites such as fleas and gamasid mites which appear to be related to the *domestic* habits of the hosts, is an economical method of investigation, because it throws as much light on the mammals as it does on a variety of ectoparasites. It is a synecological approach.

[1] Buxton, P. A., *Nature*, 155, 643 (1945).
[2] Gater, B. A. R., *Parasitology*, 24 (2), 149 and 163 (1932).

OBITUARY

Prof. A. A. Glagoleva-Arkadieva

A YEAR has passed since the death on October 30, 1945, of Alexandra Andreevna Glagoleva-Arkadieva, professor of physics at the University of Moscow. Prof. Glagoleva-Arkadieva was born in 1884. Upon leaving a secondary school in Tula, she worked as a country school-teacher during 1900–6. In 1910 she completed the Moscow Higher Courses for Women, where she studied physico-mathematics, attending lectures by Prof. A. A. Eichenwald and N. A. Umov, the physicists. Following her graduation she became an assistant in physics at the courses, which after the Revolution of 1917 were reorganised into the Second University of Moscow.

During the First World War, Glagoleva-Arkadieva organised an X-ray room at the war hospital belonging to the Higher Courses, where she designed and built an instrument called the roentgenostereometer for determining precisely the location of bullets or shell splinters in the human body. The fundamental theory of this instrument, which enabled an observer to make precise measurements of depth at any ocular distance, was worked out by the designer herself. After the War the instrument found application in midwifery. With her wealth of practical experience, Glagoleva-Arkadieva for a number of years gave a highly popular lecture course in X-rays for medical men and students.

In 1920, Glagoleva-Arkadieva initiated research in the J. C. Maxwell Laboratory at the University of Moscow on the generation of millimetre electric waves, which was necessary for the study of magnetic properties in the frequency range in which an abrupt drop in permeability of iron and nickel approaching unity had been detected in 1912. Already in 1922 she was able to report to the convention of Russian physicists on a mass radiator, on a new source of ultra-short electric waves. This source, which she described in 1924 in a communication in *Nature* (May 3, 1924, p. 640), made it possible to obtain wave-lengths from several centimetres to 82 microns. Her method consisted in passing electric sparks through a mixture of filings and viscous oil (vibrational mass). The new rays she obtained more than filled the gap between radio-waves and the long infra-red waves of Rubens that had remained in the wave scale since the time of O. Lodge and P. Lebedev. The ease of obtaining interference curves of the waves of the mass radiator pointed to the formation of undamped very short waves during spark discharges; this was corroborated by Leontieva in 1925, and more recently by H. G. Kelliher and E. T. S. Walton.

The distribution of the radiating power on the surface of the vibrational mass of the mass radiator—

the spectral composition of the radiation at its various points—was investigated by Glagoleva-Arkadieva in 1928. Simultaneously, with the aid of her wave detector thermo-element, she investigated the long-wave radiation of the mercury lamp. Since she employed a Boltzmann interferometer, she obtained a symmetrical interference curve, which was 2·5 times longer than that obtained by previous investigators; the curve gave a wave-length of 340 microns.

During 1932–33, A. A. Glagoleva-Arkadieva, employing an echelette grating, isolated from the mixed radiation of the mass radiator pure waves ranging from 9·9 mm. to 350 microns in length. In 1937 she developed a method of reticulate filters making it possible to isolate bands of definite width. The method is based on the utilization of Hertz gratings folded crosswise. The last ten years of her life found her studying the mechanism of the mass radiator and developing its theory of operation. She established that filings of irregular shape are more effective than spherical ones, and that the smallest particles still giving vibrations had a length of 0·02 mm. She showed that in the radiation of the mass radiator there are three principal waves: one conditioned by vibrations in individual grains (as in the sphere of the Lodge vibrator); another by the vibrations of a pair of grains (as in the Lebedev vibrator); while the third wave depends upon the design of the apparatus and arises from the vibrations in the chains of particles that form in the vibrational mass when sparks jump across. Her mass radiator has been applied to measurements in the field of millimetre waves, which other generators of electric vibrations do not produce.

A. A. Glagoleva-Arkadieva was able to combine her outstanding research with extensive teaching and other activity. Only in 1937, on medical advice, did she resign her position as head of a department at the Second Moscow Medical Institute, and in 1939, at the University of Moscow. She trained many teachers, medical radiographers and research workers, who have high praise for her power to imbue a love for science. By decision of the Academy of Sciences of the U.S.S.R. a collection of the papers of A. A. Glagoleva-Arkadieva is to be published.

S. VAVILOV
A. IOFFÉ

NEWS and VIEWS

Alexander Graham Bell (1847–1922)

THE name of Alexander Graham Bell, who was born in Edinburgh on March 3, 1847, will always be associated with two memorable achievements: the invention of the telephone and the education of the deaf. His interest in the human voice was inspired by his father and grandfather, both authorities in phonetics and elocution. From his mother he inherited a remarkable appreciation of tone values. In 1868 he began to teach his father's system of 'visible speech' for the deaf at a school in Kensington. Two years later he accompanied his parents to Canada, and in 1873 he was appointed professor of vocal physiology at Boston University. It was his simultaneous study of the air waves in the ear during the utterance of voice sounds, and of a tuned system of multiple telegraphy, which led to the invention of the telephone. In June 1875 he made his first telephone at Boston, and on March 10, 1876, sent the first intelligible message: "Mr. Watson, come here; I want you". His novel machine was demonstrated before the American Academy of Arts and Sciences in Boston two months later, and was introduced to the world at the Philadelphia Centennial Exhibition. The Bell Telephone Company was inaugurated in the following year. With the Volta Prize of 50,000 francs awarded by the French Government in 1880, Bell financed the Volta Bureau in Washington for the increase and diffusion of knowledge relating to the deaf. Interested in the subject of marriage of the deaf, he took up the study of eugenics, while after 1895 aviation chiefly engaged his attention.

This issue of *Nature* (dated March 1) and also that dated February 22 were not printed until after the restrictions on the use of electric power were removed on March 3

National Research Council, Canada: Appointment of Dr. David A. Keys

DR. DAVID A. KEYS, Macdonald professor of physics at McGill University, has been appointed vice-president of the National Research Council, Canada, in charge of the atomic energy establishment at Chalk River, Ontario. The National Research Council has now taken complete responsibility for the operation of this undertaking. Hitherto, the National Research Council was responsible for the Research Division on Atomic Energy, of which Dr. W. B. Lewis is director, but Defence Industries Ltd. was in charge of the construction and operation of the industrial, pilot plant facilities and the village of Deep River. Dr. Keys has had a long and impressive experience in research, scientific education and administration. Born in Toronto, he attended Upper Canada College and had a brilliant record at the Universities of Toronto and Cambridge and Harvard University. He joined the staff of McGill University in 1922.

National Research Council for Natural Sciences in Sweden

IN addition to the already existing National Research Councils for Technology, for Medicine and for Agriculture, a new Research Council for Natural Sciences has recently been established in Sweden by a royal charter. The new Council will have as its most important task the distribution of funds for fundamental research in the natural sciences and mathematics and the granting of fellowships for scientific studies and expeditions abroad. The Council will also encourage and support work for the international relations of Swedish research workers and institutions. The Swedish Parliament has granted one million Swedish crowns to the Council for the present fiscal year. The president (Prof. Arne Tiselius, Uppsala) and two other members (Prof. T. Caspersson and Prof. Bo Kalling, Stockholm) are appointed by the King. The other four members of the Council are Prof. B. Lindblad, elected by the Royal Academy of Sciences, Prof. E. Melin, elected by the University of Uppsala, Prof. B. Edlén, elected by the University of Lund, and Prof. K. Myrbäck, elected by the University of Stockholm. The secretary is Dr. G. Funke, and the address is Statens Naturvetenskapliga Forskningsråd, Besmansvägen 10, Åkeslund (Stockholm). One of the first actions of the Council has been to extend an invitation to Prof. D. R. Hartree, of the Cavendish Laboratory, Cambridge, to visit Sweden and to lecture on modern calculating machines.

British Society for the History of Science

On November 22, 1946, a meeting of persons interested in the history of science was held at the Science Museum, South Kensington. The purpose of the meeting was primarily to consider how Great Britain could best associate itself with the International Academy for the History of Science, which is about to seek affiliation with the International Council of Scientific Unions. After some discussion, it was unanimously decided that a History of Science Society should be formed, which could act as a national group and so fulfil one of the conditions necessary for association with the International Council. A committee was thereupon appointed to draw up a draft constitution for such a society. This Committee reported its recommendations to a further meeting of the original body on February 12, and as a result a provisional constitution was adopted, of which the following are the chief points.

The society is to be known as the British Society for the History of Science, and its objects are to further the study of the history of science (*a*) by meetings for the reading and discussion of papers; (*b*) by facilitating the publication of relevant material; (*c*) by co-operation with other interested bodies; and (*d*) by any other means that the Council of the Society may consider desirable. Membership is to be open to all interested in the subject who satisfy certain formal conditions, on payment of a subscription which for the first year is to be one guinea. The committee which drafted the constitution is to remain in office until the first annual general meeting, which is to be held in May next, when officers and council are to be elected. The provisional honorary secretary is Mr. F. H. C. Butler, "Ravensmead", Keston, Kent. He will be glad to hear from any who wish to become members. Steps for making the existence of the Society known are under consideration, and a statement will be issued in due course.

A Biological News-Letter

Biologists will be interested in the new Monthly News Letter *Biologia* which Dr. Frans Verdoorn is publishing as a supplement to *Chronica Botanica*. The intention is that this News Letter should be kept small and informal, as previous experience has shown that more extensive news magazines tend not to be read and well used by those for whom they have been prepared. It is the intention in *Biologia* to print information relating to methodological and professional aspects of biology rather than to publish special articles or subjects for discussion. In the first issue, that for January 1947, biologists will find much contemporary information which they might otherwise, in a busy life, tend to overlook. It contains, for example, brief references to a wide range of current biological activities such as UNESCO's first general conference, notices of various scientific congresses and meetings, new editions of such books as "The International Rules of Botanical Nomenclature", the International Zoological Station at Naples, a list of research scholarships, fellowships and grants supported by industry in the United States, scientific institutions in the Ukraine, and so on. The biological world thus owes a further debt of gratitude to Dr. Verdoorn for his many activities in their interest.

A New Heat-absorbing and Heat-resisting Glass

The German name for the focus of a lens, *Brennpunkt*, records an observation that is only too well known to both professional and amateur cinema operators. All our ordinary sources of white light radiate a large amount of energy at 'infra-red' frequencies, and a material such as a film placed in the image of a strong source may readily absorb this energy even if it transmits most of the visible light, and be likely to burn unless the exposure is very short. Various efforts have been made to avoid this trouble by producing a filter which will remove the infra-red while transmitting the visible. Water-cells are sometimes employed, but they are inconvenient and not very efficient. The late Sir William Crookes experimented with various glasses. One which he produced had a good infra-red absorption, but had a strong green colour in any thickness more than about 2 mm.; it was said to contain iron in the ferrous condition. One of the troubles with glasses of this kind is that they are subject to marked heating; and unless the filter is uniformly illuminated and heated there must be unequal expansion. Unless the material has a low thermal expansion it may crack.

Messrs. Chance Bros., Ltd., have recently produced a new heat-absorbing glass, *ON* 19, which represents a considerable advance on one previously listed in their catalogue. If the source is an ordinary gas-filled lamp of the projection type, it is claimed that, at a thickness of 6·0 mm., a sheet of this glass will transmit 81 per cent of the visible light, but only 4·5 per cent of the heat; it is said to be virtually colourless, and of good durability, moreover, having good heat-resisting properties. For use in projection systems, it is suggested that it should normally be placed near the condensers, on the side of the lamp; some form of forced cooling is usually necessary. The filter can sometimes be cut into strips further to reduce the risk of fracture. The glass is stocked in rolled sheets, 5–6 mm. in thickness. It is likely to contain scattered fine bubbles and is not intended for optical use other than as a filter. It should find many useful technical and scientific applications.

Royal Astronomical Society: Officers

The following have been elected officers of the Royal Astronomical Society: *President*, Prof. W. M. H. Greaves, Astronomer Royal for Scotland and professor of astronomy in the University of Edinburgh; *Vice-Presidents*, Miss M. G. Adam, chief assistant (astronomy), University Observatory, Oxford; Dr. M. Davidson; Prof. H. H. Plaskett, Savilian professor of astronomy, University of Oxford; D. H. Sadler, superintendent of the Nautical Almanac; *Treasurer*, Sir Harold Spencer Jones, Astronomer Royal; *Secretaries*, Prof. W. H. McCrea, professor of mathematics, University of London (Royal Holloway College); Dr. A. D. Thackeray, assistant director, Solar Physics Observatory, Cambridge; *Foreign Secretary*, Prof. F. J. M.

Stratton, professor of astrophysics and director of the Observatories, University of Cambridge; *Council*, Dr. R. d'E. Atkinson, chief assistant, Royal Observatory, Greenwich; B. C. Browne, lecturer in geodesy, University of Cambridge; Dr. H. A. Brück, John Couch Adams astronomer, and assistant director of the Cambridge Observatory; D. L. Edwards, director of the Norman Lockyer Observatory, Sidmouth; Dr. M. A. Ellison; C. C. L. Gregory, director and Wilson observer, University of London Observatory; F. Hoyle, lecturer in mathematics, University of Cambridge; Dr. A. Hunter, assistant, Royal Observatory, Greenwich; Dr. E. H. Linfoot, lecturer in mathematics, University of Bristol; P. J. Melotte, assistant, Royal Observatory, Greenwich; Prof. E. A. Milne, Rouse Ball professor of mathematics, University of Oxford; Dr. W. H. Steavenson, Gresham professor in astronomy.

Institution of Electrical Engineers Scholarships

The Council of the Institution of Electrical Engineers is offering the following scholarships: *Research Scholarships:* Ferranti Scholarship (£250 a year for two years); Oliver Lodge Scholarship (£250 for one year); Swan Memorial Scholarship (£150 for one year); C. P. Sparks War Thanksgiving Fund (a grant not exceeding £100 for one year). *Student Scholarships:* Duddell Scholarship (£150 a year for three years); Manville Scholarship (£150 a year for three years); Silvanus Thompson Scholarship (£100 a year plus fees for two years); Salomons Scholarship (£100 for one year); David Hughes Scholarship (£100 for one year); Paul Scholarship (£50 a year for two years); Thorrowgood Scholarship (£25 a year for two years). Particulars and nomination forms, to be returned by April 15 (student scholarships) or June 1 (research scholarships), can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, London, W.C.2.

University of Leeds: Appointments

The following appointments have been made in the University of Leeds: Dr. A. J. Brown, lately fellow of All Souls College, Oxford, to be professor of economics and head of the Department of Economics and Commerce; Dr. A. L. Roberts, senior lecturer in refractory materials, to be Livesey professor of coal, gas and fuel industries; Dr. G. S. Rushbrooke, Brotherton research lecturer in physical chemistry, to be lecturer in mathematical chemistry.

The Night Sky in March

Full moon occurs on March 7d. 03h. 15m. U.T. and new moon on March 22d. 16h. 34m. The following conjunctions with the moon take place: March 4d. 02h., Saturn 4° S.; March 12d. 15h., Jupiter 0·5° N.; March 19d. 01h., Venus 5° N.; March 20d. 20h., Mercury 7° N.; March 21d. 04h., Mars 4° N.; March 31d. 07h., Saturn 4° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Mars on March 16d. 17h., Mercury being 7° N. Mercury, in inferior conjunction with the sun on March 8, is not favourably placed for observation in the early part of the month. On March 15 the planet rises at 5h. 42m., and on March 31 at 5h. 06m., and can be seen in the eastern sky; but is a difficult object although its stellar magnitude is less than 1 at the end of March, because sunrise takes place only 35 minutes and 45 minutes later on the above dates. Venus is conspicuous as a morning star, rising at 5h. 02m., 4h. 57m., and 4h. 40m., at the beginning, middle and end of the month, respectively. The surface of the illuminated disk varies from 0·643 to 0·736 and the stellar magnitude is about − 3·6 during the month. Mars is not well placed for observation. Jupiter can be seen close to β Scorpii, rising at 0h. 48m., 23h. 54m. and 22h. 49m. at the beginning, middle and end of the month, respectively. The mean stellar magnitude of Jupiter is − 1·8 during March, and the planet is stationary on March 14. Saturn is visible up to the early morning hours, setting at 5h. 37m., 4h. 39m. and 3h. 35m. at the beginning, middle and end of the month respectively. The planet is easily recognized a little west of γ and δ Cancris, its stellar magnitude being 0·2. Occultations of stars brighter than magnitude 6 are as follows: March 3d. 00h. 20·3m., 52 Gemi. (*D*); March 29d. 22h. 46·8m., 37 Gemi. (*D*). The latitude of Greenwich is assumed and *D* refers to disappearance. In addition to these occultations of stars, Uranus (mag. 6) is occulted on March 1d. 01h. 08·1m. Spring equinox occurs on March 21d. 11h.

Announcements

The annual Mather Lecture of the Textile Institute will be delivered by Sir Walter Haworth, professor of chemistry in the University of Birmingham, on the occasion of the annual general meeting of the Institute on April 23; his subject will be "The Chemistry of the Polysaccharides".

Dr. F. W. Haywood, who has been chief metallurgist of Wild-Barfield Electric Furnaces, Ltd., since 1938, has been appointed to the Board of the Company as technical director.

The Challenger Society is prepared to consider applications for small grants in aid of research in marine biology or oceanography at a recognized laboratory during the year April 1947–April 1948. Applications, accompanied by details of the proposed research, should reach the honorary secretary, Mr. Dilwyn John, British Museum (Natural History), London, S.W.7, before April 19.

A Radiocommunication Convention, dealing particularly with war-time activities and their possible influence on peace-time development, has been arranged by the Institution of Electrical Engineers, and will be held at the Institution during March 25–28. Sessions will be devoted to such topics as long-distance point-to-point communication; naval, military and aeronautical communication; pulse communication; short-distance communication; direction finding; and war-time broadcasting. Sir Stanley Angwin will deliver an address on "Telecommunication in War".

Erratum.—In the letter by Dr. G. Whittingham on "The Luminous Decomposition of Nitrous Oxide", in *Nature* of February 15, p. 232: (*a*) 4 lines from foot of the first column, for "due to nitrous oxide" read "due to nitrogen peroxide"; (*b*) last sentence should read "Both these reactions require a high energy of activation[10], and sufficient nitric oxide to give a visible glow with the atomic oxygen present is not produced until high temperatures are attained".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Gyro Interaction of Radio Waves

A THEORY of the interaction of radio waves in the ionosphere, first reported by Tellegen[1] in 1933 and afterwards observed by many others, was given by Bailey and Martyn[2]. According to this theory, the modulation M impressed by the interfering long-wave station on the medium wave-length transmission reflected from the ionosphere in the vicinity of the long-wave station is

$$M = \text{const.} \frac{PD}{\sqrt{1 + \left(\frac{n}{G\nu_0}\right)^2}}, \quad (1)$$

where P is the power, D the depth of modulation and $n/2\pi$ the modulation frequency of the long-wave station. ν_0 is the collision frequency of an electron in thermal equilibrium with the gas molecules in that portion of the E-layer traversed by the wave of medium wave-length. The quantity G is a constant which relates the mean fractional loss of energy of $\overline{\lambda}$ of an electron in collisions with molecules of the gas to the collision frequency ν in a state of motion where the mean energy of agitation of the electrons slightly exceeds that of the gas molecules.

According to Pidduck and Bailey,

$$\overline{\lambda} = G\left(1 - \frac{\nu_0^2}{\nu^2}\right). \quad (2)$$

The laboratory experiments of Townsend and Tizard[3] give $G = 2 \cdot 6 \times 10^{-3}$ for ordinary air, but G may well have a different value in the E-layer.

Expression (1) for the impressed modulation was found by Bailey and Martyn[4] to fit the quantitative observations of van der Pol and van der Mark, with $G\nu_0 = 780$.

According to the first formulation of the theory of Bailey and Martyn, the impressed modulation M, other factors remaining the same, should diminish with the wave-length of the interfering station and should be negligible in practice when the interfering station operates on a medium wave-length. Afterwards, Bailey published[5] a revised theory according to which strong interaction, still described by formula (1), is to be expected when the interfering station operates on or near the gyro-frequency $\omega_0/2\pi = Be/2\pi m$, where B is the total intensity of the earth's magnetic field in the E-layer. Although qualitative observations of this gyro-interaction have been reported[6], it was considered desirable, in view of the practical importance of the phenomenon, both in setting a possible upper limit to the power of a broadcast station operating near the gyro-frequency, and also as a tool for ionospheric research, to carry out some quantitative tests of the theory. The tests, the results of which are given below, were made possible through the courtesy of Mr. H. Bishop, controller of engineering, and of the Engineering Research Department of the British Broadcasting Corporation.

In both tests long-wave transmissions from Droitwich (200 kc./s.) were observed at Dundee after reflexion from the ionosphere to the south (as required by the theory) of the interfering station at Stagshaw (1,050 kc./s.), near Hexham in Northumberland. In the first test, carried out during 0000–0200 B.S.T. July 18, 1946, the existence of the phenomenon of gyro interaction was confirmed and was observed at Dundee using a commercial broadcast receiver, with transmissions from the low-power station at Stagshaw (10 kW. at 1,149 kc./s.)—the gyro-frequency being 1,170 kc./s. Much stronger interaction over the range of audible modulation tones 100–900 c./s. was observed with the higher-power transmitter at Stagshaw (120 kW. at 1,050 kc./s.).

The second series of tests, carried out early in November 1946, was designed to check the validity of formula (1), using the higher-power transmitter at Stagshaw, and Droitwich (200 kc./s.).

Formula (1) may be written,

$$n^2 = \frac{(\text{const.})^2 (G\nu_0)^2 P^2 D^2}{M^2} - (G\nu_0)^2. \quad (3)$$

Thus, if the theory be correct, a linear relation should exist between the square of the angular frequency and the square of the reciprocal of the depth of the impressed modulation.

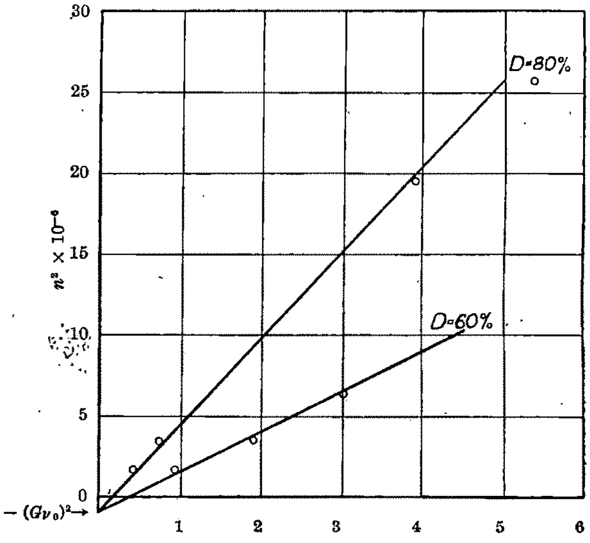


Fig. 1

Fig. 1 shows how the experimental observations accord with expression (3). It can be seen that the points corresponding to a power $P = 120$ kW. and depths of modulation $D = 80$ and 60 per cent lie near straight lines the common intercept of which with the n^2-axis is $-(G\nu_0)^2$. The value of $G\nu_0$ found from the intercept is $G\nu_0 = 950$.

Unfortunately, the accuracy of the measurements at the lower powers P and modulation depths D were poor owing to interference from a distant Russian station operating on the Droitwich wave-length. The points plotted in Fig. 1, however, represent trustworthy measurements.

A further test of the theory was also made. It is implicit in the theory, although not stressed by Bailey, that, accompanying the impressed modulation M given by (1), there is an impressed modulation at the octave frequency $(2n/2\pi)$ the depth of which, M_{oct}, is related to M as follows:

$$R = \frac{M_{\text{oct}}}{M} = \frac{D}{4}\left[\frac{n^2 + (G\nu_0)^2}{4n^2 + (G\nu_0)^2}\right]^{1/2}, \quad (4)$$

whence,
$$\frac{1}{n^2} = \frac{3}{(G\nu_0)^2\left[\left(\frac{D}{4R}\right)^2 - 1\right]} - \frac{1}{(G\nu_0)^2}. \qquad (5)$$

Fig. 2 gives the line representing $1/n^3$ as a function of $1/\left[\left(\frac{D}{4R}\right)^2 - 1\right]$ assuming $G\nu_0 = 950$, from the first measurements. The line is completely determined by $G\nu_0$ since it cuts the horizontal axis at a distance $\frac{1}{3}$ from the origin and the vertical axis at a distance $-1/(G\nu_0)^2$.

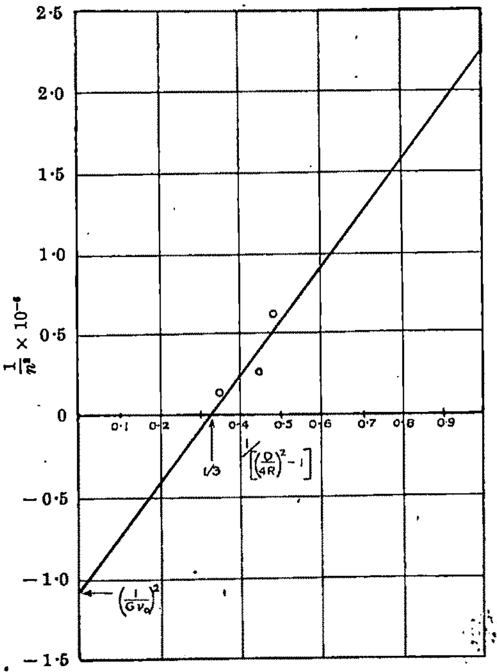


Fig. 2

Measurements of $R = M_{\text{oct}}/M$, with $P = 120$ kW. and $D = 60$ per cent, were made at $n/2\pi = 200$, 300 and 400 c./s., using a harmonic analyser.

Reference to Fig. 2 shows that the experimental points lie very near the line corresponding to $G\nu_0 = 950$; $\left(\frac{1}{(G\nu_0)^2} = 1\cdot1 \times 10^6\right)$. A third harmonic was also detected.

On the basis of these tests and of Bailey's theory, the modulation observed at Dundee is represented by the formula

$$M = 7\cdot8 \times 10^{-4} \frac{PD}{\sqrt{1 + \left(\frac{n}{950}\right)^2}},$$

where P is in kilowatts, M and D in percentages.

These investigations are of a preliminary character, and it is proposed to continue the work. From these results we estimate that if Stagshaw had operated on the gyro-frequency the impressed modulation at 100 c./s. would have been as great as 13 per cent with a transmitted power of 120 kilowatts. Such a station could, therefore, seriously interfere with other transmissions. We are indebted to Mr. J. A. Ratcliffe and Mr. S. J. Shaw, of the Cavendish Laboratory, for observing that the Droitwich transmissions were unmodulated before reaching Stagshaw.

We wish to express our appreciation of the assistance and co-operation we have received from Messrs. Kirke and Wilson, and in particular from Mr. R. A. Rowden, of the Engineering Research Department of the British Broadcasting Corporation.

L. G. H. HUXLEY
H. G. FOSTER
C. C. NEWTON
Department of Electrical Engineering,
University of Birmingham.
Jan. 6.

[1] *Nature*, **131**, 840 (1933).
[2] *Nature*, **133**, 218 (1934); *Phil. Mag.*, **18**, 369 (1934).
[3] *Proc. Roy. Soc.*, A, **88**, 336 (1913).
[4] *Nature*, **135**, 585 (1935).
[5] *Nature*, **139**, 68 (1937); *Phil. Mag.*, vii, 23, No. 157 (1937).
[6] *Nature*, **139**, 838 (1937).
General reference: "The Behaviour of Slow Electrons in Gases", Section 6.5, R. H. Healey and J. W. Reed (Amalgamated Wireless (Australasia), Ltd.).

Range-Energy Relation for Protons and α-Particles in the New Ilford 'Nuclear Research' Emulsions

WE have recently completed an investigation to determine the relation between the energy of protons, α-particles and other light nuclei and their range in the new Ilford 'Nuclear Research' emulsions[1]. A complete account of the experiments is now in the press[2], but in view of present delays in publication and for the convenience of other workers we wish to give a short account of the results.

The method employed was to determine the mean range in the emulsion of homogeneous groups of α-particles from the natural radioactive elements, and of protons from various well-known disintegration reactions. In the latter experiments, homogeneous beams of primary deuterons of known speed were employed, and the disintegration particles were observed in conditions of good geometry. It was thus possible to calculate the energy of the groups of particles, produced by various transmutations, from the known masses of the reacting nuclei. Experiments with targets of five of the light elements bombarded with 900 keV. deuterons enabled us to determine the range in the emulsion of twelve homogeneous groups of protons, of various energies in the interval from 2 to 13 MeV., and to construct a curve showing the relation between energy and range.

It is convenient to represent the results in terms of the mean stopping power of emulsion. This quantity, S, is defined as the ratio of the mean range in standard air of a group of particles of given energy to their mean range in the emulsion. In determining S from our observations, we used the values given by Livingston and Bethe for the ranges in standard air of protons of different energy.

In Fig. 1, Curve *a* shows the average stopping power of the B 1 type of emulsion for protons of different range. To determine the energy of a homogeneous group of protons of mean range, r, in the emulsion, the stopping power S_r corresponding to this range is found from the curve. The corresponding range in air, R, is given by the relation $R = S \times r$, and the energy, corresponding to this value of the range in air, can be deduced from the Livingston–Bethe curves. Curve *b* shows similar results for α-particles. In this case, in addition to the groups of α-particles emitted from samarium and from some of the heavy radioactive elements, we made use of the long-range α-particle group from the reaction Li$^6_3$ (d,α) He$^4_2$.

Although our observations are confined to the B 1 type of the 'Nuclear Research' emulsions, we believe

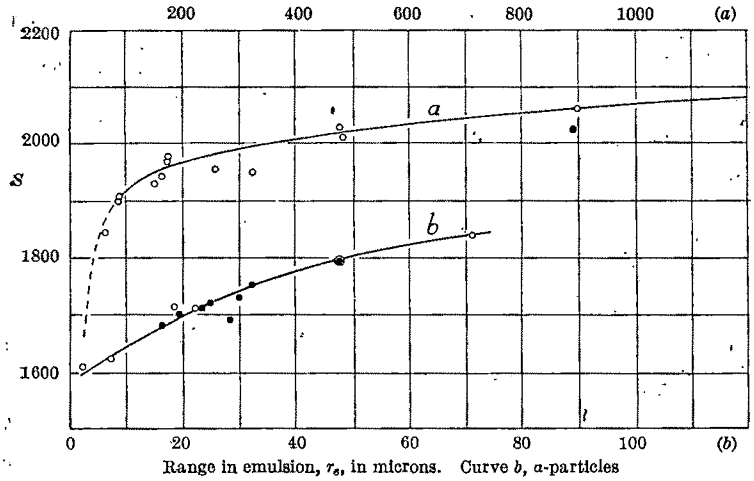
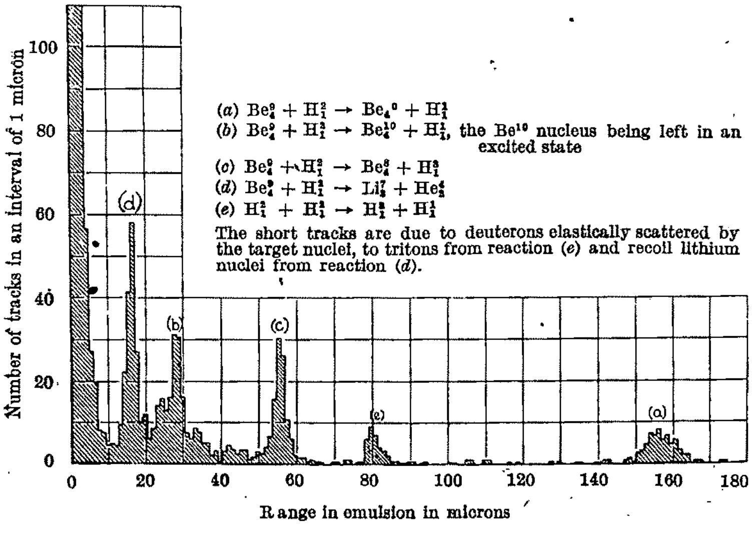


Fig. 1. ○, Present experiments; ●, Gibson, Green and Livesey's experiments

that the atomic composition of the other types, *C* 1, *C* 2, *E* 2, etc., is so nearly equal to that of *B* 1 that the present results may be generally applied without serious error. This view is strengthened by the results of experiments by Gibson, Green and Livesey with the *C* 2 emulsion, in which the ranges of α-particles from the heavy radioactive elements were determined. Points representing their observations are included in Curve *b*, and it will be seen that they are very close to those derived from the present experiments. According to the measurements of Tsien, Chastel, Faraggi and Vigneron[3], and to our own observations on the range of the α-particles of thorium *C′*, the *A* 1 emulsion has a slightly higher stopping power for α-particles than *B* 1 or *C* 2.

We may direct attention to two other features of the method in the conditions provided by the new emulsions.

First, as an example of its 'resolving power', Fig. 2 shows the distribution in range of 2,000 tracks, produced by the disintegration particles emitted from a thin evaporated film of beryllium bombarded by 900 keV. deuterons. The reactions giving rise to the particles composing the different peaks are indicated. The 'widths' of the peaks produced by the groups of protons are only a little greater than the value to be attributed to 'straggling', finite target thickness, etc. We may conclude that the precision with which the energy of a proton can be determined from the length of the track which it produces in the emulsion is now limited only by straggling.



(*a*) $Be^9_4 + H^2_1 \rightarrow Be_4{}^{10} + H^1_1$

(*b*) $Be^9_4 + H^2_1 \rightarrow Be^{10}_4 + H^1_1$, the Be^{10} nucleus being left in an excited state

(*c*) $Be^9_4 + H^2_1 \rightarrow Be^8_4 + H^3_1$

(*d*) $Be^9_4 + H^2_1 \rightarrow Li^7_3 + He^4_2$

(*e*) $H^2_1 + H^2_1 \rightarrow H^3_1 + H^1_1$

The short tracks are due to deuterons elastically scattered by the target nuclei, to tritons from reaction (*e*) and recoil lithium nuclei from reaction (*d*).

Secondly, the 'discriminating power' of the *B* 1 emulsion, although inferior to that of *C* 1 and *E* 1, is sufficiently great to allow us to distinguish the tracks of protons from those of α-particles of the same range. We are thus able to observe homogeneous groups of protons in the presence of α-particles, and to determine their mean range. As a result of the discriminating power of the emulsion we can show that peak (*b*) of Fig. 2 is due to protons. The mean range of the particles is such that they cannot have been produced by the disintegration of any of the light elements which might have been present as an impurity in the target. We therefore ascribe them to the reaction $Be^9_4 + H^2_1 \rightarrow Be^{10}_4 + H^1_1$, the Be^{10}_4 nuclei being formed in an excited state at 2·2 MeV.

We are indebted to Messrs. Gibson, Green and Livesey for permission to quote the results of the ranges of α-particles in the *C* 2 emulsion. We have pleasure in thanking Dr. Burcham and Mr. Livesey, who made it possible for us to obtain exposures to the beam of deuterons from the Cambridge high-tension generator.

C. M. G. Lattes
P. H. Fowler
P. Cuer

H. H. Wills Physical Laboratory,
University of Bristol. Jan. 2.

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[1] Powell, Occhialini, Livesey and Chilton, *J. Sci. Instr.*, 23, 102 (1946).

[2] Lattes, Fowler and Cuer, *Proc. Phys. Soc.*, in the press.

[3] Tsien, Chastel, Faraggi and Vigneron, *C.R. Acad. Sci. Paris*, 223, 571 (1946).

Surface Formation of Lithium Negative Ions

Some years ago, Arnot[1] directed attention to the fact that bombardment of a surface with positive ions resulted in the liberation of negative ions of the same species. Shortly afterwards, Sloane and Press[2], using a double mass spectrometer and employing magnetic sorting of both the bombarding positive ion beam and the resulting negative ions, were able to prove that bombardment of a surface by positive ions of a given kind could result in the formation of a whole spectrum of negative ions.

We have recently bombarded a nickel surface with positive ions from a lithium thermionic source, and detected two peaks in the resulting negative ion spectrum due to ions with mass-to-charge ratios of 7 and 6 in atomic units. The ratio of the 7 and 6 peak heights in the spectrum is approximately 10 to 1, which is about what would be expected for the lithium isotopes. Both peaks contain ions with energies in excess of that imparted to them by the accelerating electric fields, a property which seems to be characteristic of negative ions produced by positive-ion bombardment of surfaces[1,2].

We also detected two negative ion peaks with mass-to-charge ratios 23 and 22, again with peak heights in approximately the ratio of the lithium isotopes. This ratio was maintained under different experimental conditions, although the relative intensities of neighbouring peaks at 24, 25 and 26 varied markedly. These observations suggest that 23 and 22 may be due to $Li_7O_{16}^-$ and $Li_6O_{16}^-$, an interesting possibility in view of the fact that 23, when reported before[3], has been attributed to Na^-. One of us (R. H. S.) and J. F. I. Cole recorded the 23 peak last year while bombarding a tantalum gauze with ions from a Kunsman sodium positive-ion source; but, because of its behaviour when experimental conditions were altered, hesitation was felt in attributing it to Na^-. It was always so small that the possible presence of 22 could not be checked.

These new results do not, of course, preclude the existence of a stable sodium negative ion; but they do appear to show that a negative ion peak at 23 can be due to a lithium compound, and that it is unwise to identify it as Na^- unless the peak due to 22 is simultaneously shown to be less intense than it would be if it were due to the compound containing the other lithium isotope.

In their important pioneer work on this subject K. S. Woodcock[4] and J. S. Thompson[5] bombarded surfaces with positive ions from a lithium source but did not record Li^-.

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H. M. LOVE

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[1] Arnot and Milligan, *Proc. Roy. Soc.*, A, **156**, 538 (1936). Arnot, *Proc. Roy. Soc.*, A, **158**, 137 (1937); *Proc. Roy. Soc.*, A, **158**, 157 (1937).

[2] Sloane, R. H., and Press, R., *Nature*, **141**, 872 (1938); *Proc. Roy. Soc.*, A, **168**, 284 (1938).

[3] Schaefer, H., and Walcher, W., *Z. Phys.*, **121**, 679 (1943).

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Uranium Not a Superconductor

It has recently been reported[1] that Justi has found uranium to become superconducting at 1·25° K. About a year ago, I looked for superconductivity in a very pure sample of uranium using the magnetic moment method. Below about 1·45° K. a slight diamagnetic effect appeared, as if about 0·5 per cent by volume of the metal had become superconducting; the critical field of this slight effect was about 210 gauss at the lowest temperature used (1·08° K.). Similar behaviour has previously been observed[2] for titanium and for a less pure sample of uranium, and it was then suggested that the slight superconducting effect is due to an impurity. The present results considered in conjunction with the chemical analysis of the sample suggest that the superconducting impurity may be uranium carbide, but I have not yet had an opportunity of testing this suggestion by direct investigation of a uranium carbide specimen.

It seems, then, that uranium is not a superconductor down to 1·08° K., and this illustrates the danger of drawing definite conclusions about possible superconductivity from resistance measurements alone (such as Justi used). A superconducting impurity, though only a small fraction of the volume, may shunt the bulk of the metal and cause the resistance to fall, but the magnetic moment provides a direct measure of the fraction which is superconducting.

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[2] Shoenberg, D., *Proc. Camb. Phil. Soc.*, **36**, 84 (1940).

Stabilizing Linear Particle Accelerators by Means of Grid Lenses

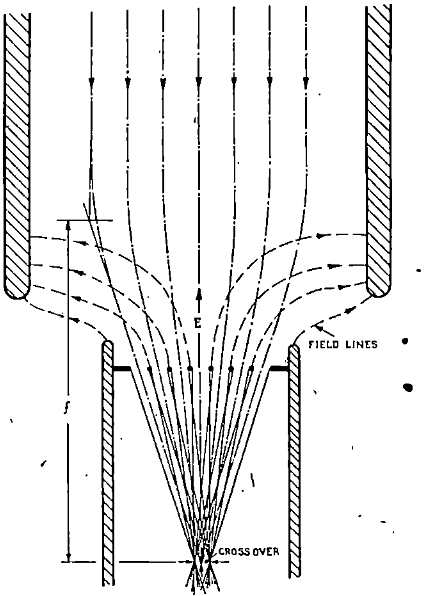
Though nothing appears to have been published, it is now fairly generally known that linear particle accelerators of the standing-wave type cannot be satisfactorily stabilized with electron lenses of conventional design for energies much exceeding about 10 MeV. I have confirmed this in an investigation starting from first principles, which showed also that lenses terminated at the exit end by a thin metal foil, such as the beryllium windows proposed by L. Alvarez of Berkeley University, promise satisfactory stability up to at least 1,000 MeV. On the suggestion of Prof. M. L. Oliphant, I extended the theory also to lenses in which the metal foil is replaced by a wire mesh grid or the like. 'Grid lenses' were investigated experimentally by Knoll and Ruska in the early days of electron optics, but they have largely fallen into oblivion. It appears now that they may well be revived for the concentration of the beam in linear accelerators, as they offer advantages equal if not superior to beryllium foils.

A gap open at one end and terminated at the other end by a conducting foil, with an electric field intensity E in the centre of the foil, acts as a condensing lens if E is accelerating. Introducing the foil produces an additional lens-power

$$\frac{1}{f} = \frac{1}{2}\frac{(1-\beta^2)^{1/2}}{\beta^2}\frac{eE}{m_0c^2},$$

where f is the focal length. As explained in the figure, this effect arises not at the foil, but by the divergence of the electric field at the other end. In the paraxial approximation it is independent of the shape of the foil.

If now the foil is replaced by a wire mesh grid or the like, with square or round holes, the beam is



FIELD AND ELECTRON TRAJECTORIES IN GRID LENS split up into a great number of fine pencils. In first approximation, each one of these pencils is collimated in itself; that is to say, within each mesh the lens effect produced by E is exactly compensated. But the global or macroscopic concentrating effect is by no means destroyed, as the central rays of the pencils suffer no deflexion. The effect of replacing the foil by a grid is merely that of replacing the point focus by a cross-over, which to a first approximation has the size and shape of a single grid hole. The next higher approximations (finite depth of the grid, lens effect quadratic in E, and spherical aberration) have all signs which point in a beneficial direction, that is to say, they tend to make the cross-over even smaller than a mesh hole.

With modern techniques it is possible to produce slat grids of a great variety of metals with clear areas of 98 and even 99 per cent, which can stand beam energies of several hundred watts per cm.^{2}. The danger of auto-electronic discharges starting from the sharp edges of the slats need not be very serious, as sufficient stability of operation can be obtained if the average field intensity E over the surface of the grid is only 10 per cent of the maximum or even less. Thus it appears that grid lenses may well compete with beryllium foils in the stabilization of linear accelerators for extreme energies.

I am indebted to Prof. Oliphant for his suggestion, and to the directors of the British Thomson-Houston Company for permission to publish this note.

D. Gabor

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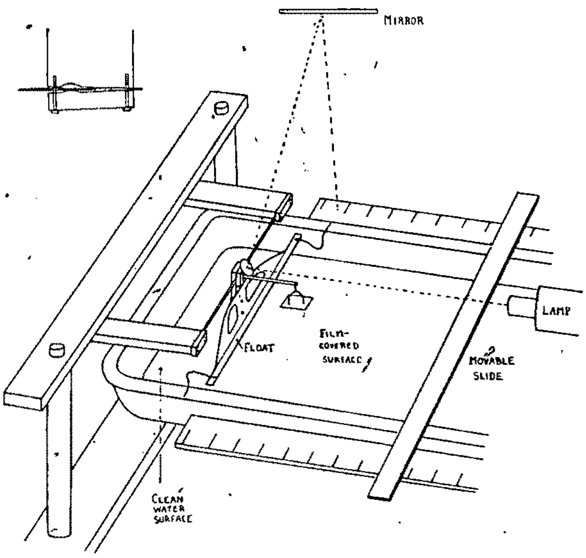
A Simple Film Balance for Demonstration and Research Purposes

The Langmuir–Adam film balance was developed to measure the lowering of surface tension (termed the surface pressure) produced by paraffin-chain compounds such as oleic acid when spread as monolayers on aqueous solutions. With substances giving condensed films (for example, stearic acid, cetyl alcohol) the sudden lowering of surface tension when the molecules are squeezed into close-packing provides a striking lecture demonstration, and many simple experiments illustrating molecular orientation, changes of phase and physical state in two-dimensions, etc., can be demonstrated by this means. In addition, the film balance has been widely applied for research purposes, particularly to problems of colloidal systems, such as foams, emulsions, proteins and polymers; to structure determination of complex organic molecules, and recently to surface-area determination of fine powders by adsorption of long-chain polar compounds from organic solvents.

To cater for the greatly increased interest in surface chemistry, the present type of film balance was devised. In addition to simplicity of construction it has some advantages over the usual type employing a torsion balance. The principle can be seen from the accompanying figure.



The monolayer is merely compressed by the usual waxed glass slide against a relatively stout torsion wire, or better, a thin metal strip (the use of a strip is preferred as it automatically brings the float to a fixed position), and the resulting deflexion of the float amplified optically as shown. The reflecting mirror shown at the top of the figure is located by means of a tall stand almost vertically above the far end of the torsion arm. A two-metre optical path has been found convenient for ordinary purposes. One of the horizontal scales used to indicate the position of the movable barrier also serves to measure the optical deflexions and hence the force on the float. Errors in film area due to the movement of the float are usually negligible (they can be allowed for if necessary), since this movement is deliberately kept very small. With a distance of 2 cm. between the torsion wire (strip) and the float, 1 mm. movement corresponds to 20 cm. deflexion at 2 metres. The torsion wire or strip is suitably chosen so that the float movement does not exceed c. 1 mm. for the maximum surface pressures encountered. Thin steel watch spring has been found very suitable for the usual film pressures, that is, of the order 10–50 dynes/cm. The torsion wire or strip can readily be changed merely by loosening the simple clips at its ends, and no difficulty in tightening it sufficiently has so far been encountered, but if necessary the device shown inset can be used.

The float consists of thin duralumin (or other metal) sheet, turned up at the edge and screwed to the vertical duralumin bar to which the torsion wire or strip is clamped. For research purposes a thin mica strip is attached by wax beneath the float to keep all metal out of contact with the solution. A rectangular 'Pyrex' baking-dish, or the glass dish used in 'Frigidaire' refrigerators, provides an excellent trough after the bevelled edges have been ground flat.

Calibration can be carried out in the usual way by adding weights to the small pan (a light wire ring and piece of paper) shown in the figure, or by spreading 'piston oils', such as castor oil or oleic acid, which give known surface pressures.

This apparatus appears to give an accuracy fully equal to that of the usual torsion balance, with the additional advantage that measurements can be carried out much more rapidly. It can also be used for automatic recording of force-area curves, and in addition can readily be adapted to measure surface or interfacial tensions.

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Reflectivity of Steel

THE method briefly described in these columns[1] some time ago was employed in an investigation of the reflectivity of two kinds of steel at different temperatures. The two specimens were 'stainless' steel, and no special precautions were taken to ensure an oxide-free atmosphere. Their composition was as follows: *SF*11, 13 per cent chromium; *SF*20, 18 per cent chromium, 8 per cent nickel. The measurements were carried out for two wave-lengths, 0·55 and 0·65 μ, and extended over a range of more than 300° C. The room-temperature results are listed in Table 1.

TABLE 1. REFLECTIVITY IN %

λ	0·55μ	0·65μ
*SF*11	50·1	54·5
*SF*20	64·8	66·4

Those for *SF*20 belong to the highest found in the literature, being in fair agreement with the values obtained by Pfestorf[2] (on Krupp *V2a* Edelstahl). Generally, it is impossible to carry out any comparisons, since few authors give adequate data on the composition of their specimens. The temptation to ascribe the higher reflectivity of *SF*20 to its nickel content must be resisted: in some comprehensive work which covered the visible and ultra-violet parts of the spectrum, von Fragstein[3] has found it impossible to detect any systematic variation in the reflectivity with the composition of his steel specimens. Such a variation is only likely to be found in the far infra-red.

The temperature coefficient of reflectivity is defined by

$$\alpha_\lambda = \frac{1}{R_\lambda} \cdot \frac{dR_\lambda}{dT}.$$

The values obtained in the present investigation and given in Table 2 refer to room-temperature. Since dR/dT is less dependent on the manner in which the mirror has been prepared than α, the values for the gradient proper are also presented.

TABLE 2

	0·55 μ		0·65 μ	
	dR/dT	α	dR/dT	α
*SF*11	$+1{\cdot}43\times10^{-2}$	$+2{\cdot}8\times10^{-4}$	0	0
*SF*20	$+3{\cdot}75\times10^{-3}$	$+5{\cdot}78\times10^{-4}$	$+7{\cdot}5\times10^{-3}$	$+1{\cdot}13\times10^{-4}$

As might have been expected, the mirrors tarnished when high temperatures were employed. It was interesting to observe that the reflectivity on the short wave-length side of the spectrum decreased before that near the red end. A comparison with the work of Banning[4] and Sabine[5] shows that, in the case of aluminium, the ultra-violet reflectivity is greater for the specimen which had not been exposed to air before measurements were taken. Since the reflectivities of pure aluminium and its oxide are practically the same in the visible region, it is possible to assume that the oxide layer formed by the atmosphere on the aluminium is extremely thin. This has been accounted for theoretically by Mott[6]. It would then appear that the thickness of the film in the case of steel is such as to reduce the reflectivity in a manner analogous to that of aluminium, except that the diminution occurs in the visible region. It is likely that such a film is only a transitional phenomenon for, when the mirror was heated to a temperature of more than 500° C., it turned blue. It is assumed that the predominant reflectivity of the red in the early stages is due to the film being opaque to wave-lengths shorter than these, and that the blue appearance later is due to interference phenomena in the thicker film itself.

Lastly, it is seen that $\alpha_{0\cdot65\mu} = 0$ for *SF*11. Such a point has been termed an X-point by Price[7], and is said to be characteristic of each metal. While its significance from the point of view of pyrometry cannot be over-estimated, especially if this coefficient should be zero over large temperature ranges, it is not thought that it has any fundamental value. Its existence can be predicted at least qualitatively on the basis of classical electro-magnetic and electronic theory. A complete analysis of this fact will be given on another occasion.

The above work has been carried out under the auspices of the Pyrometry Sub-Committee of the British Iron and Steel Research Association. I am indebted to the Committee for permission to publish this account, and to Mr. W. C. Heselwood, of the United Steel Companies, Ltd., Sheffield, for the supply of the specimens.

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Jan. 2.

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Choice of a 'Reality Index' for Suspected Cyclic Variations

IN *Nature* of December 21, Dr. W. Gleissberg proposes an index R for estimating the reality of cyclic variations in a series of observations. This index involves the average length L of a 'run' and the standard deviation S, about this mean, as calculated by Kermack and McKendrick[1]. The object of this communication is not to discuss the arguments for or against the proposed index, but to point out an error of a somewhat subtle type which occurs in the example given by Dr. Gleissberg. Figures are given representing the heights of sunspot maxima for 18 consecutive periods. The mean length of the runs, L, is 2·4, which is very close to the theoretical mean, 2·5. Consequently the reality index, $R = D^2/D^2+S^2$, where $D = L - 2{\cdot}5$, is small. So far as this test goes, the fluctuations may well be random ones and not dependent on 'real' cyclic variations.

In order to eliminate accidental or experimental errors, Dr. Gleissberg proceeds to take running averages of the observations in groups of four, the first group consisting of the first four observations a, b, c and d, the second of b, c, d and e, the third of c, d, e and f, and so on. In this way he obtains fifteen averages each of four observations, and goes on to calculate the value of the reality index R for this derived set. The mean length L is found to be 3·8, which exceeds 2·5 by 1·3, a quantity very large in comparison with the standard deviation, and R comes out very nearly unity.

A little consideration shows that this calculation is quite inappropriate for a series derived, as above, by forming running averages. The mean length of a 'run' L is 2·5 in an infinite series, n_1, n_2 . . ., n_x . . ., of, say, random decimals between 0 and 1. But the numbers derived from such a random series by taking running averages of groups of t or, what for present purposes is essentially equivalent, taking the sums $\sum_{x=1}^{t} n_x$, $\sum_{x=2}^{+1} n_x$, . . . $\sum_{x=m}^{t+m-1} n_x$, no longer form a random series, and the average length of a 'run' is no longer 2·5. It is not difficult, in fact, to show that, whatever t may be, the average length of a 'run' is 3·0, except in the special case when $t = 1$. The following does not claim to be strictly rigorous.

First take the exceptional case $t = 1$. Any number in a series of random numbers is a 'maximum' when it is greater than the preceding and succeeding numbers. But by hypothesis these are three numbers taken at random, and the probability that of three such numbers the middle one should be the greatest is clearly $\frac{1}{3}$. Thus the probability that any number in the series should be a 'maximum' is $\frac{1}{3}$. Similarly, the probability that any number should be a 'minimum' is also one third. If we have a long series containing N numbers, there will be approximately $2N/3$ 'extrema' ('maxima' and 'minima'), and it follows at once that the average length of a 'run' is 2·5, the length as explained in Dr. Gleissberg's letter being the number of numbers in the 'run', including the first and the last.

Let us now take $t = 4$; it is easily seen that the argument holds when $t \geqslant 2$. If the original series is $a, b, c, d, e, f, \ldots$, the derived series is $(a+b+c+d)$, $(b+c+d+e)$, $(c+d+e+f)$ . . . Clearly the middle term will be a 'maximum' provided e is greater than a and b is greater than f. But there is a probability of each of these conditions being fulfilled of $\frac{1}{2}$, and the two events are independent as the original series is a random one, and so the probability of the two events occurring together is $\frac{1}{4}$. Thus in the derived series one quarter, and not one third, of all the numbers are 'maxima', and one quarter are similarly 'minima'; one half of all the numbers are 'extrema'. It readily follows that the average length of a 'run' is now 3 and not 2·5. The standard deviation of the lengths of 'runs' about the mean length would presumably differ from the special case where $t = 1$, but its calculation would be more involved.

To test these results, the first two hundred of Fisher and Yates' random numbers were taken from their tables (Statistical Tables for Biological, Agricultural and Medical Research). These numbers each contained only two digits, and this means in effect that we are limited to a hundred different numbers instead of an infinite population. However, the deviation from the theory occasioned by this limitation is but slight. Where two consecutive numbers are equal, they were counted as one 'extremum'.

It was found that the series of two hundred numbers contained 129 'extrema'. Taking $t = 2$, that is, the series $(a+b)$, $(b+c)$, $(c+d)$ . . ., etc., the number of 'extrema' was 96. Taking $t = 4$, that is, the series $(a+b+c+d)$, $(b+c+d+e)$ . . ., etc., the number of 'extrema' was 94. These results may be compared with the expected values of $\frac{2}{3}$ $(200-2) = 132$ in the case of the series of two hundred numbers (the first and last of the two hundred numbers are excluded in the calculation as they cannot figure in 'extrema'), 98·5 in the case of $t = 2$ and 97·5 in the case of $t = 4$. Clearly, for $t = 2$ and $t = 4$, the number of 'extrema' found agrees closely with that required by the above theory, but differs considerably from what would be expected in a really random series.

The above considerations do not disprove Dr. Gleissberg's final conclusion that there is an underlying cyclic variation in the sunspot maxima, obscured by some random effects; but they do suggest that this particular application of his reality index is not rigorously sound. If this, or any similar index, meets with general acceptance, it is important that the conditions under which it can be applied should be adhered to.

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Dec. 31.

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[1] *Proc. Roy. Soc. Edin.*, 57, 228 (1936).

Spiral Cracks in Glass Tubes

I believe that the interesting experiments recently reported in *Nature*[1] cannot, for symmetry reasons, be explained on the ordinary theory of strength of homogeneous materials; but an attempt at a qualitative study of the spiral cracks according to Griffith's views on the phenomena of rupture[2] may be developed as follows.

If we assume that at normal temperature 'Pyrex' glass possesses some kind of porosity with a random distribution of small spherical cavities, the surface tensions acting along these inner boundaries oppose themselves to thermal dilatation and, consequently, in heated glass, many spherical cavities will be deformed into ellipsoids. Both eccentricity and stress concentration at the ends of the major axis will increase with temperature.

As in rapid breakings the hypothesis of fracture propagation in the direction of maximum strain seems quite admissible, we have to calculate the most unfavourable orientation of the major axes of the cavities from which the cracks will start. To a first approximation, we can consider a plane plate with elliptic holes of given average eccentricity undergoing a tensile stress, and keep the deductions valid for the external layer of the annealed tubes.

Denote by φ the angle between the direction of stress S (at infinity) and the major axis of the hole; then the extension L of the axis can be expressed in the well-known form: $L = S\,(A\cos^2\varphi + B\sin^2\varphi + 2C\sin\varphi\cos\varphi)$, where A, B are coefficients of elasticity for tensile stresses parallel to the axes of the ellipse, and C (the value of which is not strongly influenced by eccentricity) is the analogous coefficient for a pure shearing stress.

L is a maximum in the directions determined by the equation: $tg 2\varphi = 2C|(B - A)|$.

Now, the difference $|(B - A)|$ depends upon eccentricity and increases with temperature: hence φ and the helix pitch decrease; moreover, L, too, increases with temperature, and so does its derivative with respect to φ; $L_{\text{max.}}$ is more sharply defined, and this explains why at high temperature the cracks are more regular; their finer structure may be caused by the rapidity of formation, as for dynamical compression tests on paraffin at normal temperature[3].

At still higher temperature, φ becomes very small and possibly less than the limits determining the phenomenon; in this case the crack is closed and we have segmentation.

Finally, at low temperature, φ should approach 45°; but during the same time, the variations of L with respect to φ greatly diminish, rupture is no longer very rapid and it occurs statically (along a generatrix) rather than dynamically (at 45°); so we only have straight or steep wavy lines.

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C.so Gal. Ferraris 90,
Torino.
Dec. 16.

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[1] *Nature*, **158**, 582 (1946).

[2] Griffith, A. A., *Phil. Trans. Roy. Soc.*, **221**, 163 (1921).

[3] Cf. Nádai, "Plasticity" (McGraw-Hill, 1931), 111.

Electrogenic Properties of Acetylcholine

FOLLOWING the classical work of Dale on acetylcholine, numerous investigators have demonstrated the important part played by this quaternary amine in the nervous system[1]. A neglected property of acetylcholine is its extraordinary electrogenic action at the phase boundary between oils and aqueous solutions[2]. This negative phase boundary potential provides a possible explanation of the electrical component of the nerve impulse in cholinergic nerves[3]. It seems reasonable to suppose that the action potential[4] might arise from the contact of acetylcholine with the lipoid layer of the nerve fibre according to the theory of phase-boundary potentials[5]. Moreover, it has been shown that acetylcholine produces a negative electrical potential on living frog skin[6].

The penetration of acetylcholine into an oil layer can be determined by measurements of the fall in resistance of oil in contact with solutions of acetylcholine in physiological saline. For E.M.F. studies, equal parts of cholesterol are added to the oil, but for conductivity measurements more uniform results are obtained with a pure solvent. Guaiacol[7] has several properties found in protoplasm, such as its conductivity, and the property of distinguishing between potassium and sodium and, above all, absorbing lipoid-soluble substances. 20 c.c. samples of guaiacol were shaken for five hours with 100 c.c. samples of the aqueous solutions. In a typical experiment (at 25° C.) the oil had a specific resistance of 140×10^4 ohms after shaking with saline; 25×10^4 ohms after shaking with 50 mgm. per cent acetylcholine in saline; 19×10^4 ohms after shaking with 100 mgm. per cent acetylcholine in saline; 10×10^4 ohms after shaking with 200 mgm. per cent acetylcholine in saline.

The measured phase-boundary potential of 50 mgm. per cent acetylcholine in saline in contact with guaiacol was 35 mV. (negativity), which is close to the value of 45 mV. calculated from the above data. According to the Nernst equation, the potential can be calculated as the logarithm of the difference in concentration of the common ion (difference in conductivity of oil in contact with sodium chloride and in contact with acetylcholine chloride—a seven-fold difference) multiplied by the factor 0·058 for room temperature.

The fall in resistance of nerve during activity might be explained as the fall in resistance of the nerve lipoid layer produced by the penetration of acetylcholine. There is no longer need to postulate the breakdown of an imaginary Bernstein membrane[8].

If an electroencephalograph is employed instead of the usual potentiometer to measure the electrical change produced by adding acetylcholine to an oil layer, it is found that the negativity rises very rapidly, resembling the upstroke of the spike potential in nerve. The downstroke of the spike potential in nerve might be produced by the acetylcholine reaching the opposite side of the extremely thin oil layer at the surface of the nerve fibre. There is also the possibility that the enzyme choline esterase[9] destroys the acetylcholine potential, thus forming the downstroke of the spike potential in nerve. Acetylcholine solutions were shaken with esterase preparations and the potentials measured at an oil boundary. In a typical experiment, two 200 c.c. samples of saline containing 50 mgm. per cent acetylcholine with 100 mgm. per cent bicarbonate and 6 gm. of minced fresh cat brain (cortex) gave phase boundary potentials of 7 and 3 mV. negative in contact with 10 per cent cholesterol in guaiacol, compared with 32 and 29 mV. negative given by two control solutions of identical composition but containing no brain substance. 200 c.c. of saline with 100 mgm. per cent bicarbonate but no acetylcholine or brain and shaken for the same time (5 hr.) gave a potential of 7 mV. positive. 1 mgm. per cent eserine and also 0·05 per cent di-isopropyl fluorophosphate preserved the electrogenic properties of acetylcholine solutions in the presence of esterase; but other workers[10] have found that these anti-esterase agents fail to prolong the spike potential in nerve, showing that esterase is not essential for the formation of the electrical nerve impulse. In living cholinergic nerve, esterase probably has a minor function of removing excess acetylcholine.

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Jan. 10.

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Partition-Chromatography and Living Cells

CHROMATOGRAPHY appears likely to play an important part in future work on protein analysis. The partition method[1,2], whereby amino-acids can be separated and identified on a cellulose strip, is sensitive to extremely small amounts of material. For example, 1 μgm. of an amino-acid gives a clearly visible colour reaction with ninhydrin. The method may ultimately, therefore, prove valuable for the protein analysis of the chromosomes and their products. With suitable solvents and developers, it should be possible to separate and determine the nucleic acids, as well as amino-acids. In our preliminary experiments, the method has been used to survey the presence of free amino-acids in plant and animal tissues at different stages of nuclear activity.

The following tissues have been tested: salivary glands of *Drosophila*, root tips of *Trillium*, anthers of *Tradescantia* at various stages of meiosis and pollen formation, and the white and yolk of a hen's egg.

Small amounts of the tissues and separated egg were smeared direct on to filter-paper strips; the crushed root tips being attached by means of a starch support. As a check on the possibility of protein degradation after death, a duplicate smear of each cell type was fixed by flooding with ethyl alcohol; but no difference in results was found. The paper strips were run in one dimension only, using water-saturated phenol as the solvent. The air-tight chamber in which separations were carried out contained a two-phase solution of water and phenol at the bottom. After 24 hours treatment, the filter-paper strips were dried in a water-oven at 98° C., sprayed with ninhydrin and dried again in the oven to allow the colour spots to develop. Only two kinds of result were obtained: (1) no coloration (that is, no free amino-acids): salivary glands and white of egg; (2) two or more colour bands indicating the presence of two or more free amino-acids: all the plant cells and yolk of egg.

The nature and exact location of the free amino-acids is at the moment a matter for speculation. Previous work by the use of other methods has already shown them to be present in plant tissues[3]. Whether their absence in salivary glands can be attributed to the absence of mitosis remains to be shown.

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Merton Park, S.W.19.

[1] Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **35**, 1358 (1941).

[2] Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **37**, Proc. xiii (1943).

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Metabolism of Fatty Livers

Earlier work on the metabolism of fatty livers by Ennor[1] showed that the oxygen consumption and the acetoacetic acid production of liver slices from guinea pigs poisoned with carbon tetrachloride is considerably in excess of normal. Since adenosinetriphosphate is essential for the oxidation of fatty acids[2], it was considered of interest to determine a possible correlation between high-energy phosphate content and the increased metabolism of such livers.

0·1 ml. of carbon tetrachloride in arachis oil was given by subcutaneous injection to well-fed guinea pigs of approximately 300 gm. body-weight. Two to four doses were given at 24–48 hour intervals, and both control and treated animals were starved for 24 hours before killing. The major portion of the liver was dropped into liquid air within 30 sec. of the death of the animal; the remainder of the liver was taken for fat, nitrogen and total phosphorus determinations. Duplicate samples of the powdered, frozen liver were extracted twice with trichloracetic acid and, after removal of the protein, aliquots were taken for an analysis of the barium-insoluble fraction precipitable at pH 8·2. Determinations were made of the inorganic phosphorus originally present and that released on heating at 100° C. in *N* sulphuric acid for varying time intervals up to three hours. All figures are calculated on the basis of the nitrogen content of the original liver.

From the accompanying table it will be seen that the readily hydrolysable phosphorus (7 min.) is higher in the livers of the treated animals than in the control series. The relative amounts of adenosine di- and tri-phosphates present in this fraction have not been fully established; but it is of interest that the increase, due primarily to the presence of these compounds, is associated with the increase in metabolism found in fatty livers of this type.

Controls			Treated		
No. of expt.	N gm. %	mgm. % P on 7 min. hyd.	No. of expt.	N gm. %	mgm. % P on 7 min. hyd.
34	3·89	1·2	35	2·15	4·5
37	3·58	1·7	38	2·53	2·1
39	3·63	1·1	47	1·85	3·7
52	3·25	1·0	53	1·84	3·3
56	3·51	1·6	57	2·20	2·8

A full report of this work will appear elsewhere.

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* Holding a Research Fellowship from the Wellcome Trustees.

[1] Ennor, A. H., *Austral. J. Exp. Biol. and Med. Sci.*, **20**, 73 (1942).

[2] Lehninger, A. L., *J. Biol. Chem.*, **154**, 309 (1944).

Mechanism of the Action of X-Rays on Enzymes in Water-Solution

It is a well-established fact[1] that the action of ionizing rays on substances dissolved in water often proceeds in a way suggesting an interaction of some irradiation products of the water molecules. As regards the nature of these hypothetical intermediary products and the mechanism of the action on the dissolved substances, Weiss[2] has discussed the possible formation of H-atoms and OH-radicals. The biological significance of the reactions has also been tentatively discussed. If a second component is added, the action of X-rays on the substance under consideration may change owing to dissipation of the primary X-ray products between the two substances.

Some experiments may further elucidate the mechanism. The X-ray dose given was 12·400 r., the intensity 275 r./m. The enzyme studied here was pure crystalline catalase[3] diluted to a concentration of $3{\cdot}7 \times 10^{-6}$ gm./ml. The experiments were run at pH 7·4 and in an atmosphere of nitrogen in order to avoid the interaction of gaseous oxygen; 6–12 tests were used for each substance (see accompanying table).

Substance added (conc. 0·1–0·2 m*M*.)	Inactivation (per cent)
Enzyme alone	53·9 ± 1·4
Maleic (fumaric) acid	30·9 ± 3·2
Malonic acid	54·3 ± 2·1
Succinic acid	53·1 ± 0·9
Pyruvic acid	40·8 ± 1·7
Lævulinic acid	46·3 ± 3·6
Glutathione	71·0 ± 3·7
Oxidized glutathione	30·2 ± 1·3
Cysteine	67·5 ± 7·4
Cystine	28·6 ± 1·4

Unsaturated substances, which may be expected to react with the water products (for example, fumaric and maleic acids), act as protective systems. Related saturated acids (malonic and succinic acids) show no signs of influence, whereas ketocarbonic acids, for example, pyruvic and lævulinic acids, are protective (the latter in a less pronounced manner).

Some of the other experiments reported in the table are more instructive as to the mechanism of the reaction. Glutathione (cysteine) increases, whereas oxidized glutathione (cystine) decreases the action of X-rays; for this we suggest the following explanation. Suppose the water is primarily split into H-atoms and OH-radicals. In the presence of glutathione (or cysteine) the reaction $2RSH + OH \rightarrow 2RSSR + H_2O + H$ may occur to some extent, thus increasing the chances of a reaction between the enzyme and the H-atoms. In the presence of the oxidized product, the reverse takes place. According to this conception the action will *in this instance* be exerted by free H-atoms. The protection of the ketocarbonic acids may then be considered to depend on a reduction of these substances. Another X-ray reaction may be mentioned in this connexion. Fricke[4] has shown that pure water is not measurably decomposed by X-rays, but it is in the presence of small amounts of iodine ions (1·0–0·01 millimol.). Formation of hydrogen peroxide, and in unbuffered or alkaline solution also oxygen, that is, oxidizing products, can be proved. It is conceivable that the presence of iodine ions will decrease the amount of free hydrogen atoms. Now the addition of such quantities of iodine ions affords a very strong protection for the catalase against the X-rays, so that doses up to ten times as big must be given in order to obtain the same effect as without the iodine ions.

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[1] Cf. Fricke, H., in various papers, for example, *Phil. Mag.*, **7**, 129 (1929); *J. Chem. Phys.*, **6**, 224 (1938). Dale, W. M., *Biochem. J.*, **34**, 1367 (1940); **36**, 80 (1940); *Nature*, **151**, 280 (1943).

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[3] Forssberg, A., *Ark. Kemi*, **21A**, No. 7 (1945); *Acta Radiol.*, **27**, 281 (1946).

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Action of Light upon Jute

THE treatment of jute with certain alkylating and acylating agents inhibits the discoloration which this fibre, in common with most ligno-cellulosic fibres, undergoes on exposure to light[1,2].

One approach to a better understanding of the factors involved in the discoloration and in its prevention is afforded by a study of the chemical reactions which take place on irradiation. Samples of jute yarn and powder have been exposed to the light of a quartz mercury-vapour lamp; the yellow-brown colour produced is the result of two or more reactions leading to the formation of yellow and brown reaction products. A large part of these derivatives is soluble in water, and the yellow to brown colour of the solution is intensified on addition of alkali but reduced by the action of sulphur dioxide. It is clear that the soluble, coloured reaction products are of relatively small molecular weight and that they are derived mainly from the ligneous encrusting materials, though degradation products of the hemicellulosic constituents may also be involved. Irradiation leads to a reduction in the yield of lignin-forming units and a reduced yield of furfuraldehyde. Furthermore, the methoxyl content of lignin isolated from irradiated jute is lower than that of the comparable fraction from a non-irradiated sample. Demethoxylation of the lignin-forming units to polyhydroxy phenolic fission products, which are converted to quininoid forms, and the formation of furfural polymers or furfural-phenol condensation compounds, are held to be the sources of the coloured derivatives.

The formation of these coloured compounds can be prevented either by removal of the lignin or by acetylation. Methylation with an ethereal solution of diazomethane only partially inhibits the reactions. Irradiation of an acetylated sample results in a loss of acetyl groups, the major portion of which can be recovered as free acetic acid, though the presence of a small amount of bound acetic acid, liberated after hydrolysis with potash, has been noted. It is concluded that irradiation of acetylated and methylated jute produces substituted polyhydroxy phenols which are incapable of forming coloured quinones. The bleaching of acetylated jute, which occurs on irradiation, is not observed with methylated jute. This is probably due to the labile acetyl groups forming a bleaching agent such as acetyl peroxide, which has been shown to bring about the bleaching of acetylated jute. Acetylation, as an aid to colour inhibition, appears, therefore, to have the two functions of preventing quinone formation and causing the production of a bleaching agent during irradiation.

I wish to thank the Indian Jute Mills Association Research Institute for permission to publish this note.

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[2] Peill, P. L. D., *Nature*, **158**, 554 (1946).

Artificial 'Breaking' of the Diapause in *Drosophila nitens*

LABORATORY strains of *Drosophila nitens* Buzzati-T., though kept under constant conditions of temperature and lighting, are known[1] to undergo a winter diapause (November–March) at the imago stage. A few individuals reproduce in winter, but at a very slow rate. This was a handicap to genetical studies on this species.

It is known that various external stimuli may 'break' the diapause of the insects, although the mechanism of their action is not completely understood[2]. Our experiments showed that individuals of *Drosophila nitens* exposed to low temperature (ten days at 2–5° C.) one month from the beginning of the diapause, after which they were kept again at 25° C., are induced to 'break' the diapause and reproduce actively. Egg-laying is high; the larvæ develop at a normal rate; the adults emerged reproduce again, as if the winter period had been overcome.

From an ecological and physiological point of view, it will be interesting to see when the treated strains will undergo the diapause again, since their reproductive period began precociously: that datum will be of importance in seeking causes of the seasonal cycle of the species.

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Jan. 13.

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A CONTINUUM THEORY OF RHEOLOGICAL PHENOMENA

By Dr. K. WEISSENBERG

When materials of different kinds are subjected to mechanical actions we may observe a great variety of rheological phenomena, and we shall confine our attention here to a certain group of them which allows a theoretical and experimental investigation on a macroscopic scale. Here then, as in the classical theories of elasticity and hydrodynamics, we can treat the materials as continuous media, and the forces and displacements as vectors which vary continuously in space and time.

Let us consider first what happens in an appropriately chosen cycle of rheological states. We start with a material in a *ground-state*, that is, in a state in which every portion is at rest and free from external forces. We then impose some mechanical action and thereby bring the material into the particular *energized* state the phenomena of which we want to investigate. Finally, to complete the cycle, we suddenly release all external forces and allow the material to drift back into some ground-state (which may or may not be the one from which it was started). We can now define as a characteristic parameter of the energized state considered, and of the phenomena produced therein, the *recoverable strain*, that is, the amount of strain recovered after the release of the forces.

An experimental investigation was carried out under Dr. C. H. Lander[1], and in this we found it convenient to classify a material as *stable* if it regains always the same mechanical properties after completing a cycle from one ground-state to another, and to refer to it as *general* or *special* in some range of rheological states, according as the recoverable strain reaches in that range finite values, or remains infinitesimally small or zero throughout. The investigation covered a wide range of stable materials comprising such solids and liquids as are homogeneous and isotropic in all their ground-states. It revealed the differences in behaviour between general and special materials rather strikingly under certain conditions, as is illustrated in Fig. 1 for liquids, that is, for materials which flow under any shearing stress, however small.

The experimental arrangement is such that the liquid is sheared in a gap between an outer vessel rotated with an angular velocity that is kept constant at various levels, and an inner member which is held against rotation and either rigidly fixed in position or free to move up and down the axis of rotation. The conditions are so chosen that under the combined actions of the shear imposed at the boundaries, and the forces of gravity and inertia (centrifugal forces), the liquid executes a stationary laminar shearing movement.

An analysis of the experimental results shows that in such a motion the stress has its strength so distributed over the various directions in space as to comprise, in addition to the shear stress components, a pull along the lines of flow. We obtained direct experimental evidence for the presence or absence of such a pull by suddenly stopping the motion, and then making cuts perpendicular to the lines of flow. The general liquid used had a time of relaxation sufficiently long for the stress to persist appreciably after the stoppage, and the pull component present in this stress caused the cuts to open up. This pull distinguishes the general liquids from the special ones, being of finite amount or infinitesimally small when the recoverable strain is finite or infinitesimal. (Liquids which are in a certain range 'general' must in the same range be 'non-Newtonian' or 'anomalous'; while liquids which are 'special' may be 'Newtonian' or 'normal', but need not be so.) If, as in our experiments, the lines of flow are closed circles, the pull along these lines strangulates the liquid and forces it inwards against the centrifugal forces and upwards against the forces of gravity. The presence and absence of such a strangulation is illustrated in Fig. 1 under the column divisions headed respectively "General Liquids" and "Special Liquids". I am greatly indebted to Dr. Lander and to his collaborators, Dr. P. Rosin, Dr. H. Fehling, Mr. M. Deutsch and Mr. R. J. Russell[2], for the generous help they gave me in these experiments, and to Mr. S. M. Freeman for many improvements in the experimental technique. My thanks are also due to Dr. F. H. Garner and Dr. A. H. Nissan who, on being informed of the results obtained and while continuing their own lines of research[3], suggested a useful arrangement of pressure gauges (see Fig. 1, row 6).

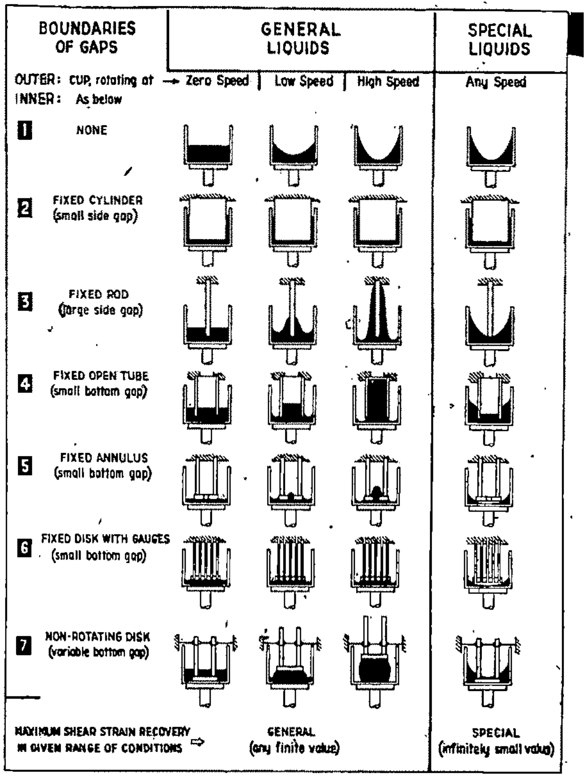
BOUNDARIES OF GAPS
GENERAL LIQUIDS
SPECIAL LIQUIDS
OUTER: CUP, rotating at →
INNER: As below
Zero Speed
Low Speed
High Speed
Any Speed
1 NONE
2 FIXED CYLINDER (small side gap)
3 FIXED ROD (large side gap)
4 FIXED OPEN TUBE (small bottom gap)
5 FIXED ANNULUS (small bottom gap)
6 FIXED DISK WITH GAUGES (small bottom gap)
7 NON-ROTATING DISK (variable bottom gap)
MAXIMUM SHEAR STRAIN RECOVERY IN GIVEN RANGE OF CONDITIONS ⇨
GENERAL (any finite value)
SPECIAL (infinitely small value)

Fig. 1. FLOW OF LIQUIDS UNDER ACTIONS OF STATIONARY SHEAR IN GAPS

A continuum theory was developed for the rheological states of general and special materials, along the lines of the classical treatment of elastic continua. As a first approximation a theory was proposed[4], containing an arbitrarily assumed law of elasticity, and from this theory predictions were made for a pull along the lines of flow and for a great variety of rheological phenomena, including such as are reproduced in Fig. 1. The experimental investigation under Dr. Lander (1943–45) then revealed that in a variety of materials, including saponified oils, solutions of rubber, starch, cellulose acetate, etc., the predicted phenomena actually occur, but with a systematic discrepancy between the strength of the stress components anticipated in the various directions of space and that actually found in quantitative measurements. The discrepancy was rectified, and full agreement reached with all experimental results obtained so far, in a revised theory, in which the arbitrarily assumed law of elasticity was replaced by an empirical law of the form

$$\frac{P_{au} - P_{bv}}{R_{au} - R_{bv}} = \frac{P_{bv} - P_{cw}}{R_{bv} - R_{cw}} = \frac{P_{cw} - P_{au}}{R_{cw} - R_{au}} = G(P, R) \quad (1)$$

Here—for the energized state considered—we denote by P_{kl} the *kl* component of stress, by R_{mn} the *mn* component of the recoverable strain, measured on the classical scale as the elongation ratio squared minus unity, by *a*, *b*, *c* and *u*, *v*, *w* the numbers 1, 2, 3 or any cyclical permutation of these numbers, and by $G(P, R)$ a function of the three fundamental scalar invariants of stress and strain, and other scalar parameters such as temperature, time, etc. The function $G(P, R)$ may be regarded as a generalized modulus of elasticity, the value of which may vary with the material and the rheological state, the temperature, time, etc. This is best seen when the empirical law (1) is specialized for the case of a stationary laminar shearing movement, where the suffixes 1, 2 and 3 correspond respectively to the directions of the lines of flow, the perpendicular to the shearing plane, and the normal to both these directions, and where the recoverable strain has components R_{mn} which are all zero, except R_{11}, R_{12}, and R_{21}, with $R_{11} = (R_{12})^2 = (R_{21})^2$.

Recently, further progress was made[5] when we succeeded in replacing the empirical law of elasticity (1) by a simple theoretical assumption. We consider an elastic continuum in any energized state, and imagine it cut into two parts by a plane drawn in any direction through some arbitrarily selected point. For every such plane the traction force will define a triad of mutually perpendicular directions, according to its normal, tangential and cross-components; and a second triad is defined by taking similar components of the displacement of the two parts relative to one another when the continuum recovers to a ground-state. We can formally deduce equation (1) from the assumption of a coincidence of these two triads of directions for every plane. This assumption, and the elasticity law derived from it, have been confirmed empirically over wide ranges of materials and mechanical actions; but further experimental investigations are required, and are in fact under way, to ascertain the exact limitations of validity, since a theoretical proof can be given only under certain conditions. Keeping within the range of elastic continua which are isotropic in all the ground-states, we can prove the validity of the assumption (*a*) in all classes of rheological states for certain orientations of planes, and (*b*) for all possible orientations of planes in certain classes of rheological states, including all classes restricted either to infinitesimal small strains, or to any stresses and strains with cylindrical symmetry.

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[2] Russell, R. J., Ph.D. Thesis, Imperial College, London, 1945.

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EMERGENCY SCIENTIFIC RESEARCH BUREAU, EIRE

THE report of the Emergency Scientific Research Bureau, Eire, covering the period February 21, 1941–March 31, 1945*, which was set up with Prof. J. J. Dowling as chairman, gives brief details of the work of the Bureau.

A large part of the Bureau's experimental work dealt with fuel problems, and the most important of these included the manufacture of charcoal from turf, the efficiency of mobile producer plants, and the production of town gas under emergency conditions. Work on the production of turf charcoal led to the design, erection and operation by the Turf Development Board, Ltd., of a plant on the Turraun Bog, from which charcoal suitable for use as a producer fuel was obtained with an output of up to 22 tons a week. Work on town gas resulted in a study of the possibilities of using mixtures of turf and coal, and in modifications in plant which to some extent eased the difficulties being experienced at one of the large gas works. One of the first problems studied was that of mobile gas producers, including the use of an electric filter for the gas; but although such a filter can be constructed, it is not much more efficient, is more expensive and requires much more careful servicing. The drying of turf and the development of a gas specific gravity meter were other investigations in the same field.

Much attention was given to chemicals for the manufacture of matches, including the manufacture both of phosphorus and of potassium chlorate; while a process was also worked out for the manufacture of sulphur by dry distillation from spent oxide. Plant was also developed for the supply of compressed carbon dioxide and ammonia for refrigeration purposes, for aluminium sulphate for water purification and paper manufacture, and for the manufacture of formalin by oxidation of methyl alcohol.

A geophysical survey of mineral deposits of economic importance, and the increase in output to 20 kW. of the existing 1·5 kW. short-wave Marconi transmitter at Moydrum were other tasks undertaken.

The maintenance of such essential medical supplies as anæsthetic ether, glycerol, insulin, and vitamins, and of supplies of yeast and flour for breadmaking, and the manufacture of citric acid by fermentation were other subjects investigated.

Experimental work was also carried out on the production of carbon black by combustion of used lubricating oil, the spectrographic analysis of steel, production of ferro-silicon, electro-deposition of ductile pure iron, carburizing steel for knife-blades, refractory bricks, carbon electrodes, replacements for storage batteries, the recovery of zinc from used primary cells and the alkali treatment of Clare phosphate to give a satisfactory fertilizer. A process was developed for a photo-engraving glue from fish-skins. Work was done on acetone, and processes for ethyl acetate from 80 per cent acetic acid, for agar-agar from seaweed, for an insecticide by extraction of offal tobacco, and a substitute for cutch as a preservative for fishing nets, were also worked out by the Bureau. A modified method for the determination of fat in milk was devised. Advice was given on the use of substitutes for imported wool oil, and for economy and efficiency in the use of lubricating oils.

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* Emergency Scientific Research Bureau. Report. Pp. 96. (Dublin: Stationery Office, 1946.) 2*s*.

FORTHCOMING EVENTS

Tuesday, March 11

Zoological Society of London (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Royal Anthropological Institute (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. Brunt, F.R.S.: "Some Problems of Climate and Man".

Illuminating Engineering Society (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. J. Ivon Graham: "Lighting in Coal Mines".

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 6.30 p.m.—Dr. Thos. B. Crow and Mr. J. F. Hinsley: "Some Anomalies and Refinements in Diamond Pyramid Hardness Testing of Heavily Cold-Rolled Strip".

Institution of Structural Engineers, Lancashire and Cheshire Branch (at the College of Technology, Manchester), at 7 p.m.—Mr. W. L. MacIvor and Mr. S. R. Reisser: "Practical and Theoretical Approach to Correct Design for Welding".

Wednesday, March 12

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5 p.m.—Mr. J. A. Petch: "The Trend of Joint Matriculation Board's Examinations".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C:2), at 5 p.m.—Mr. Reco Capey: "Economic Reconstruction, 5, Craftsmanship".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. A. Van Weelden: "Modern Developments in Geophysical Prospecting".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. N. Berry: "Economics of High-Voltage Transmission by Underground Cables".

Society of Chemical Industry, Microbiological Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. B. M. Brown: "The Biological Stability of Beer"; Prof. B. T. P. Barker and Dr. V. L. S. Charley: "The Biological Stability of Cider, Fruit Juices and Soft Drinks".

Chemical Society (joint meeting with the Local Sections of the Royal Institute of Chemistry, the Society of Chemical Industry and the British Association of Chemists, at the Nicholson Lecture Theatre, New Organic Chemistry Department, The University, Dansie Street, Liverpool), at 7 p.m.—Demonstration of Scientific Apparatus.

Society of Dyers and Colourists, Northern Ireland Section (at the Queen's Hotel, Belfast), at 7.30 p.m.—Mr. J. G. Grundy: "The Application and Fastness Properties of Dyes on Nylon".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Outlook in the History of Science" (to be opened by Prof. V. Gordon Childe, Mr. A. R. Halle, Mr. J. G. Crowther and Mr. Philip George).

Thursday, March 13

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. E. W. Taylor: "The Control of Amplitude in Phase Contrast Microscopy"; Mr. J. F. P. Deller, Mr. A. D. O'Connor and Mr. A. Sorsby: "X-Ray Measurement of the Diameters of the Eye".

Illuminating Engineering Society, Manchester Centre (joint meeting with the Electrical Association for Women, at the College of Technology, Manchester), at 6 p.m.—Mr. T. O. Freeth: "Lighting the Home".

Institute of Welding, Sheffield and District Branch (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p.m.—Mr. H. E. Lardge: "Welding in the Development of Jet Propulsion Engines".

Chemical Society (joint meeting with the Local Section of the Royal Institute of Chemistry, in the Chemistry Department, The University, Manchester), at 7 p.m.—Scientific Papers.

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Mr. William C. Peck: "Recent Developments in Pharmaceutical Apparatus".

Society of Dyers and Colourists, West Riding Section (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Dr. H. P. Staudinger: "Polymer Chemistry".

Chemical Society (joint meeting with the Local Sections of the Royal Institute of Chemistry and the Society of Chemical Industry, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Prof. A. C. Chibnall, F.R.S.: "The Composition and Structure of Proteins".

Friday, March 14

Textile Institute (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. L. J. Clarke: "Some Recent Trends in Ribbon Manufacture".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Chemical Society (at King's College, Newcastle-on-Tyne), at 5 p.m.—Dr. H. Bassett: "Some Pages from the Chemistry of Aluminium" (Bedson Club Lecture).

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. J. R. Lysholm: "A Contribution to the Solution of the Gas Turbine Problem".

Oil and Colour Chemists' Association, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. E. H. Farmer: "The 'Isomerisation' of Oils—Thermal and Oxidative Changes Involved Therein".

Institute of Physics, Manchester and District Branch (joint meeting with the Industrial Radiology Group, in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. L. H. Gray: "The Physical Properties of Very High Voltage X-Rays and Electrons and their Medical Interest".

Chemical Society (in the Chemistry Lecture Theatre, The University, Glasgow), at 7.15 p.m.—Prof. A. C. Chibnall, F.R.S.: "The Composition and Structure of Proteins".

Institute of Metals, Sheffield Section (in the Mining Lecture Theatre, The University, St. George's Square, Sheffield), at 7.30 p.m.—Prof. H. W. Swift: The "Mechanism of Sheet-Metal Drawing".

Saturday, March 15

Biochemical Society (at Guy's Hospital Medical School, London, S.E.1), at 2.30 p.m.—Annual General Meeting, and Scientific Papers.

School Nature Study Union (at the City Literary Institute, Stukeley Street, Drury Lane, London, W.C.2), at 2.30 p.m.—41st Annual Conference; at 3 p.m.—Sir Clive Forster-Cooper, F.R.S.: "Adaptation to Environment".

Institute of Physics, Electronics Group (joint meeting with the Midland Branch of the Institute of Physics, in the University, Edmund Street, Birmingham), at 2.30 p.m.—Prof. P. B. Moon: "The Acceleration of Electrons and Ions to Energies of the Order of 10^8 e.v.".

Monday, March 17

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. J. A. V. Butler: "Enzymes" (Cantor Lectures, 2).

Sheffield Society of Engineers and Metallurgists (at the Royal Victoria Station Hotel, Sheffield), at 6.15 p.m.—Dr. J. Sinclair: "The Underground Mechanization of Coal Mines".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lectureship in Geography—The Registrar, The University, Reading (March 17).

Lecturer in the Department of Geography—The Secretary, The University, Aberdeen (March 20).

Assistant Lecturer in the Department of Geography—The Registrar, The University, Sheffield (March 21).

Senior Principal Scientific Officer in the Directorate of Instrument Research and Development of the Ministry of Supply—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1816 (March 21).

Chief Fuel Engineer—The Director of Establishments, Ministry of Fuel and Power, 7 Millbank, London, S.W.1, marked 'Chief Fuel Engineer' (March 21).

Training Officer—The Executive Officer, Kent War Agricultural Executive Committee, Mote House, Maidstone (March 22).

Chair of Inorganic and Physical Chemistry at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 46 North Bailey, Durham (March 22).

Senior Civil Engineering Assistant—The Water Engineer, 55 Dale Street, Liverpool (March 24).

Co-ordinator of Research and Principal at the Punjab Agricultural College, Lyallpur—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (March 28).

Principal of the School of Physiotherapy and Head of the Physiotherapy Department—The House Governor, Royal Victoria Infirmary, Newcastle-upon-Tyne (March 31).

Professional Officers for Rhodesia Meteorological Service—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (March 31).

Technical Development Officer—Establishment Branch (Room 266), Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1 (March 31).

Lecturer (woman) in the Department of Education (graduate in Biology, Chemistry or Physics)—The Registrar, University College, Hull (April 14).

Lecturer in Helminthology—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1 (April 15).

Lecturer in Physiology—The Secretary, Queen's University, Belfast (May 1).

Lecturer in Biochemistry for Department of Dental Surgery—The Registrar, The University, Liverpool (May 15).

Professorship in the Department of Chemistry—The Registrar, Dacca University, P.O. Ramna, Dacca (East Bengal). India (May 31).

Director of the South African Paint Research Association—South African Scientific Liaison Officer, 39 Princes Gate, Exhibition Road, London, S.W.7.

Assistant Biochemist preferably with experience of hospital biochemistry and hæmatology—The Medical Superintendent, Dudley Road Hospital, Birmingham 18.

Lecturer in Genetics at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1.

Senior Lecturer in Mathematics at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C:1.

Director of Research—The Physician Superintendent, Runwell Hospital for Nervous and Mental Disorders, Wickford, Essex.

Senior Transmission Engineer for Hydro-Electric Scheme, Ceylon—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1.

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INCENTIVES IN INDUSTRY

THE volume in which Dr. Elton Mayo discusses some of the social implications of scientific and technical advance which have been emphasized by the 'clinical studies' of the Department of Industrial Research of the Harvard Graduate School of Business Administration has reached Great Britain at an opportune time*. Already the necessity of finding new and adequate incentives, in conditions in which man-power and woman-power fall far short of demand and in which increase of productivity is urgent and imperative, has compelled the Government as well as both sides of industry to look closely at problems which have been neglected too long. Simultaneously, the outbreak of a succession of unofficial strikes points to the need for an overhaul of the structure and functions of the trade unions, so as to ensure closer contact between their officials and the rank and file of their membership, as well as a more effective contribution to the welfare of society. The importance of the last point is further stressed by the extent to which the nationalization of industry is changing the broad aspect of relations between employees and employers and the State, and making the strike weapon both archaic and an anti-social sectional weapon endangering the whole fabric of democracy.

Prof. Mayo's main theme is the importance of the group and of methods of understanding not merely the behaviour of individuals but also groups, whether formally organised and recognized by management, or self-constituted informal organisations ; and his book brings to the forefront the problem of securing group collaboration in the essential activities of industry. In doing this, he lays bare even more fundamental issues than Dubreuil did in his study of the autonomous group, for Prof. Mayo is alive to the wider social implications of the impact of applied science ; and in spite of some assumptions in the economic sphere, due partly to failure to define his terms, which the economist may find irritating, he has given us a book that should assist the creative thought demanded in the present situation He recognizes by implication that industry alone cannot achieve full success : there is a political aspect and an indispensable Government contribution, which he appears to contemplate discussing in a third volume. Meanwhile, he has made a valuable contribution to the educational work to be done both within industry and in the universities and technical colleges, as well as to the study of management problems themselves. His book has claims on the attention of all those concerned with the preservation of a free society, the conditions of which he delineates as three-fold : first, a sufficiently general standard of technical skill and literacy ; secondly, the absence of extreme differences in the material standards of living of its various social groups ; and thirdly, the elimination of internal group hostilities and hatreds.

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* The Social Problems of an Industrial Civilization. By Prof. Elton Mayo. Pp. xvii+150. (Boston, Mass. : Graduate School of Business Administration, Harvard University, 1945.) 2.50 dollars.

It needs no more than the most superficial glance at the events of the past year to realize that although the whole trend of policy in Great Britain during the past decade has been towards the levelling of the differences in material standards of living, the second and third conditions are as yet by no means fulfilled. Behind the recent strikes lies a question of the quality of citizenship which is only partly a trade union matter; and which is of increasing importance as more and more industry passes within the orbit, if not directly of the State itself, at least indirectly in the public corporations. Moreover, the declining level of general intelligence which Sir Cyril Burt's recent study has indicated makes it imperative that more attention should be given to this factor of education, and there is as yet little evidence from the men returning to civil life from the Services that the educational work in the Forces has proved effective in raising the level of understanding of the meaning and responsibilities of citizenship.

Increasingly we are coming to realize the searching demands that a democratic society makes of its citizens; and the supreme reason for seeking urgently and imperatively to eliminate the divisions due to group hostilities is that they present a fatal obstacle to effective participation and co-operation both within industry and also at the international level. Effective co-operation is the condition of industrial efficiency and higher productivity in Britain, just as much as it is the condition for the survival of civilization in the international sphere. Civilization, as Prof. Mayo points out, can destroy itself if it fails to understand intelligently and to control the aids and deterrents to co-operation, and his recurrent theme is that if our social skills had advanced step by step with our technical skills, there would not have been a second world war.

In the first of the two essays, "Science and Society", Prof. Mayo urges that collaboration in an industrial society, whether in a political or an industrial unit, cannot be left to chance; but hitherto all our administrative methods have been aimed at securing satisfaction of material and economic needs, and not at the equally important problem of maintaining spontaneous co-operation. Absenteeism, the turnover of labour, and unofficial strikes testify to our ignorance of how to ensure the spontaneity of co-operation, the team-work that was the characteristic of so many outstanding achievements in the scientific and technical field during the War. Moreover, we have passed beyond the stage of human organisation in which effective communication and collaboration were secured by established routines of relationship. As Lewis Mumford has pointed out, we are living in an age when we can no longer assume that the technical processes of manufacture will exist unchanged for long in any type of work.

That, of course, is one reason why conditions of full employment imply greater mobility of the workers and why it is imperative for the trade unions to re-examine their outlook and practice. Adaptability and not restriction is the condition of social security; and the very instability of techniques makes a fuller stability in companionship imperative. We have to acquire new social skills that will be effective in the specific situations, and although this must be in the main a task of management and a major responsibility of all institutions concerned with the training of those destined to occupy positions of leadership, it is a task in which every worker is also concerned. Prof. Mayo undoubtedly puts his finger on the weak spot in suggesting that the outstanding defect of civilization is the incapacity of groups to communicate effectively and intimately with each other.

The defect lies at the root of most of the acute issues developing between managements and workers, and indeed between Government and people, as it often does of the failure of men of science to secure proper appreciation by the administrator of the scientific factors in a situation. Scientific men at least are coming to appreciate more fully that, as Prof. Mayo observes, the development of usable skill must be accompanied by the acceptance of responsibility of one kind or another. The widespread manifestation of a sense of social responsibility in relation to the development of atomic energy which has characterized scientific workers in the United States and in Great Britain during the last eighteen months is possibly one of the most hopeful and healthy signs of recovery on that side.

Prof. Mayo is less happy in his second essay, in which he discusses what he terms the 'rabble hypothesis' and its corollary, the State absolute. He emphasizes in conclusion that the active development of social skill and insight is required to make the forms of democracy come alive, and he returns to this theme in the concluding chapter of the book. He argues that the only way of dealing with the industrial or the international situation is by, first, the patient, pedestrian development of first-hand knowledge; secondly, the development of skill in handling the facts through intimate acquaintance; and thirdly, the clear statement of the logical implications of the effective skill.

Modern civilization, Prof. Mayo urges, is greatly in need of a new type of administrator, who can, metaphorically speaking, stand outside the situation he is studying; and throughout the book his main emphasis lies on the organisation of co-operation, because it is so largely ignored in the universities, in industry and in political statements. Knowledge of the relevant technical skills and of the systematic ordering of operations is indeed essential; but it is to the need for close observation, for the ability to communicate and to listen, and to train students in the study of social situations that he is primarily concerned to direct attention, emphasizing that first-class technical training alone is insufficient in a modern and mechanical age.

The capacity of the individual and of the group to become adapted to new circumstances and to new relations with other people has been made a vital necessity in our adaptive society by the great pace of modern technical and industrial development; and the most disturbing feature of the present situation is that so few professional organisations, whether trade unions or not, have shown any real appreciation of the fact. It should indeed be a prime purpose of the production committees and works councils to increase this adaptability or flexibility: information is an important means to that end. The attitude indicated in what is generally known as the 'closed shop' policy is most sinister in that it threatens the existence of the very groups which might provide stability; and in so far as the formation of very large trade unions is encouraged for reasons of ease of negotiation, it is vital that within the large union something corresponding to personnel management or public relations should be developed, to ensure real contact and understanding between the national and regional leaders and the local groups and rank and file of the membership.

There follows from this the necessity for developing intensively industrial relations in their widest sense, by either the formation of workers' councils and committees, or the constant provision of full information regarding the purposes of industrial policy to the workers individually and to their organised groups. There is room for effort from both the trade union and the employers' side for initiative in this field, in order to dispel the legacy of distrust which is one obstacle to higher productivity; and the industrial psychologist may well have a vital contribution to make in raising the whole standard of what for want of a better term is known as personnel management. Included in this is the training of leaders at the lower levels of responsibility—the foreman and charge-hand on the part of industry, the shop-steward on the part of the trade unions. If management and trade unions could work out jointly a policy of selecting and training men for such positions in the best interests of industry, from the point of view of the nation, we should have taken a big step towards securing co-operation at the vital level of production and at the same time have assisted in the formation of those very groups which provide the individual with the satisfaction and security he seeks, while linking them to the service of society as a whole.

A wide field exists for further research. We need to know more about the best methods for securing adequate representation from small groups of employees in sections or departments, and for discussions of company policies or procedures prior to their introduction, and information on production, sales, finance, etc. The whole problem of incentives in industry demands a searching re-examination, and new methods are required for bringing up and discussing such matters as 'waiting time', absenteeism, raw material shortages, labour shortages, production targets and the like.

The great value of Prof. Mayo's book is the vivid way in which it indicates the practical possibilities of group co-operation and relates them to the larger problem of the renewal of democracy not merely in industry but also in the world as a whole. It is true that, however urgently they are explored, they cannot bring their full effect to the solution of the immediate problem of increasing productivity, although the very initiation of such investigations might have a profound psychological effect. A similar comment applies to remarks of the Chief Inspector of Factories in his last annual report regarding the need for a general cleansing and refit to bring British factories back to their pre-war standard, and the introduction of more light and colour to brighten them up and take them a step beyond; all this clearly depends on factors outside the control of industry itself. Shortages of labour, materials and plant—not to mention difficulties in the way of obtaining the necessary permits—undoubtedly hinder or prevent the use of such means of increasing industrial efficiency; nevertheless, it is important to recognize and acknowledge their significance in promoting better relations in industry.

Something more could certainly be done even now to raise the standards of industry generally and thereby the standard of productivity. For such improvements, in the furthering of which the man of science will often have an essential part to play, help to persuade men and women that production is indeed a social task, and by raising what, for want of a better word, may be termed the morale of workers again, assist that greater interest and effort on which higher productivity depend. Here again is a field in which the scientific worker has much to contribute. The whole question of incentives offers vast scope for investigation by the psychologist, and other men of science may indeed be able to offer contributions. For success in this matter management must be bold and imaginative, and ready to experiment. Some of the essential scientific spirit must be given free play, linked to that respect for human personality which characterizes the 'clinical studies' described by Prof. Mayo; and this must pervade the trade unions as well as management. For this reason it is important that the man of science should be associated not only with the management of industry but also with the trade unions.

There is much that is suggestive in Prof. Mayo's work, and the ideas and methods he outlines do indeed point the way forward to a closer integration of industry with the society it exists to serve, and to a fuller understanding between worker and management. Furthermore, the discussion in the dispassionate spirit of science of the implications in full employment of the forty-hour or five-day week, staggered holidays with pay, pensions and retirement, and the relation of hours of work to age and physical fitness or disability, may assist us to reach new and imaginative solutions which will permit a wiser and more efficient use of man-power and woman-power at all ages, and the greater productivity which is now our imperative need. At the same time, such studies may lead to the release of men and women in industry from some of the excessive strain to which they are likely to be subjected when they first enter industry and, at a later stage, when their working life is drawing to its close.

SCIENTIFIC POLICY FOR THE NEW WORLD

Endless Horizons

By Dr. Vannevar Bush. Pp. ix + 182. (Washington, D.C.: Public Affairs Press, 1946.) 2.50 dollars.

THE concerted effort that linked the men of science of Great Britain during the Second World War was remarkable in the ease of its occurrence, in its achievements, and, contrary to many fears, in the fact that scientific 'planning' was not apparently associated with any evil consequences—except perhaps in so far as we did not plan sufficiently for the continuation of fundamental research. We were particularly fortunate in all this, and we owe a large part of our success to the fact that in the scientific and technical departments of the Service and other Ministries, and even more so in the Department of Scientific and Industrial Research, the Medical Research Council and Agricultural Research Council, we possessed powerful official agencies to act as a kernel for our scientific mobilization.

In this respect British men of science were far better off than their colleagues in the United States. Apart from certain Service establishments, the only counterpart to British official scientific organisation which was available to them when war broke out in Europe was the National Research Council, acting under the auspices of the National Academy of Sciences. The Council was a creation of the First World War; but either its structure was unsuited, or its practical influence on the scientific life of the United States during the inter-war years was insufficiently extensive, for the task of co-ordinating scientific activity on a national scale in an all-out war effort. In 1940 the President of the United States accordingly established a new committee, the National Defense Research Committee (N.D.R.C.), for the purpose of developing new weapons and instruments of war. A year later he founded an Office of Scientific Research and Development (O.S.R.D.), which absorbed the N.D.R.C., and had the function of co-ordinating the efforts of men of science and technical men in a much wider field of the war effort.

Dr. Vannevar Bush, previously head of the engineering section of the Massachusetts Institute of Technology, and at the time president of the Carnegie Institution of Washington, was placed in charge first of the one and then of the other of these two organisations. Their success so impressed Mr. Roosevelt that, towards the conclusion of hostilities, as is now well known, he called on Dr. Bush to submit a practical plan for the consolidation of the scientific gains of the War, both in the sense of making them as widely known as was consistent with military security, and of ensuring their continued extension by discovering, educating and endowing scientific talent in the United States. The O.S.R.D. was wound up not many months ago, and it is some months since open, official discussion of Dr. Bush's reply to the President languished in silence. In the interval two relevant changes have occurred. In the first place, scientific organisation in the United States has returned to its pre-war model, with the very important distinction that the Service Departments appear to have usurped the function of O.S.R.D. as the benefactors of large-scale research projects in the universities. In the second, the British have reacted to much the same type of consideration as exercised Dr. Bush when he was framing his reply to the President's question, by increasing the scale of university education, without making any inroads into university autonomy, and by trying to improve the organisation by which scientific advice makes itself felt in the national sphere at policy-making levels.

In the light of these two events, "Endless Horizons", which was published about a year ago in the United States, makes interesting reading—or re-reading—to-day. It is a collection of Dr. Bush's public utterances, between the years 1933–45, on technical and scientific matters. Its body is his report to the President, coupled with a brief account of the organisation and achievement of the O.S.R.D. Its frame is made up of such diverse, personal materials as his image of the 1930's as seen from a far-distant future when "all the desirable modifications of our natural environment" have been accomplished through some simple mechanical means; his well-known essay on the need for mechanical recording devices which will relieve the individual of much of the effort that still goes into the processes of natural memory and the exercise of formal logic; an essay on the conditions of scientific progress, called "The Teamwork of Technicians"; one on "The Qualities of a Profession"—dealing with the special case of engineers; another on the American tradition of opportunity; a lecture on "The Need for Patent Reforms"; and finally an address on "Science for World Service".

At the time of its appearance, Dr. Bush's report to the President was the subject of a leading article in these columns, and a large number of British men of science will be aware, at least in general, of the achievements of the O.S.R.D. The only new interest of the present volume is therefore a glimpse, even if an indirect one, of Dr. Bush's personal philosophy about the meaning of scientific activity. Coming as it does from the man responsible for the blue-print of America's future scientific organisation—even if at the moment the blue-print remains unrealized—it is an important one. The note is struck in his main report: "Without scientific progress," he told the President, "no amount of achievement in other directions can insure the health, prosperity and security" of the United States as a nation in the modern world; and since scientific progress is therefore of vital interest to Government, science must—in Dr. Bush's own words—be brought to the centre of the stage, and provided with a national policy which will ensure the rapid extension of a process, the utilization of science in the nation's welfare, which has only just begun. None of this message makes strange reading in Britain. What might be unexpected, however, is the predominantly material and social flavour of Dr. Bush's credo. It characterizes not only the reasons he gives for the federal action which he proposes, but those of his essays which are completely unrelated to this question. Dr. Bush, an apostle of science in the most individualist of countries to-day, calls for a national policy for science, and high-level planning for science, in far bolder terms and in a more materialist context than any but a few, if indeed anyone, has used in Britain.

His essays in "Endless Horizons" do not reveal much preoccupation with any abstract or non-applicable science. His 'historical' view of the 1930's, which opens the collection of essays, is a racy account of such inadequate gadgets as electric light, motor-cars, and spectacles. Nor does the implied picture of the distant future in which science will have achieved all the desirable changes in these matters carry any suggestion that they will have been associated with any corresponding evolution in general understanding—beyond the implication which lies in the statement "science of the times [1930's] was disjointed, heterogeneous and very much an opportunist affair". The world, Dr. Bush explains to one of his audiences, "has arrived at an age of cheap complex devices of great reliability; and something is bound to come of it". To the President he wrote that "a nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill".

It is thus to a world of individualist enterprise that Dr. Bush makes his appeal for the establishment of a council to control the scientific policy of the United States. He may, of course, be wrong in assuming that advances in science when put to practical use necessarily "mean more jobs, higher wages, shorter hours . . . and higher standards of living"—since these things depend at least as much on socio-economic factors as on scientific progress. But whether the atmosphere be the rich and individualist one of the United States, or the Spartan and socialist one of Great Britain to-day, it seems to be generally recognized that the time has come for the State to play a central part in stimulating scientific progress.

It is equally to the interest of both countries that policy-making for science should not conflict with the peripheral autonomy of universities and research institutes in carrying out their research and educational programmes. Freedom of inquiry is a cherished possession; and, as Dr. Bush shows so clearly, because of the different and sometimes conflicting demands it must satisfy in different fields, national scientific policy is scarcely likely to lend itself to easy formulation. By itself science provides "no panacea for individual, social and economic ills". There is a possibility, to which Dr. Bush does not refer, that the widespread extension of scientific knowledge, and its methods, might achieve more in this respect than the direct exploitation of the material gains of science. Perhaps he deliberately avoided emphasizing this not-so-materialist point of view. History, however, will judge of the value of a national scientific policy by the wisdom of the compromise it effects between the more immediate satisfaction of domestic demands of security and economic and social welfare, and the longer-term necessity to spread the methods and fruits of scientific knowledge as widely and as internationally as possible.

S. Zuckerman

THE LIQUID STATE

Kinetic Theory of Liquids

By J. Frenkel. (International Series of Monographs on Physics.) Pp. xi+488. (Oxford: Clarendon Press; London: Oxford University Press, 1946.) 40*s*. net.

This book does a great service by collecting together much scattered information on a fascinating and rapidly developing subject, contributions to which have appeared in a great many different journals. Discussion of liquids inevitably leads on to such topics as fusion and evaporation, the theory of solutions, the properties of polymers and rubber-like substances, and so on. Certain of these topics are dealt with at considerable length, others rather sketchily, and it is regrettable that no attempt has been made to link up the statistical theory of turbulence with the molecular theory of liquids. As is inevitable in so vast a subject, some of the matter is already out of date, and it is only right to mention that the book was written in Moscow in 1942, and has suffered delay in publication. In spite of these shortcomings, the book fills a very obvious gap, and cannot fail to be of permanent value to a serious student of any of these subjects. In spite of the War, the book is printed on very nice paper, and the high standard of craftsmanship that one instinctively associates with this series of monographs has been well maintained. The references are given in footnotes, which is far more convenient than grouping them at the end of the chapters, but one would welcome a complete bibliography at the end of the book, or else a subject index. Another improvement that could easily be made in a new edition is the addition of a list of symbols.

The reviewer feels bound to take exception to an objectionable feature of the book, which is the very scornful way in which the work of others is criticized. In a rapidly advancing subject it is inevitable that many theoretical deductions will be found to be based on erroneous premises, and a detailed criticism of such theories is of great value, and is, indeed, necessary for progress. In some instances, however, the author appears to think that a few words are enough to annihilate the rival theory, and, in at least one instance (p. 155 footnote), he does not attempt to explain his objections at all. Such an attitude is both unfair to the author of the theory and unhelpful to the reader who is trying to decide between two points of view. The reviewer quite agrees that many of these criticisms are justified, but there are cases where the author has been beguiled into definite errors by this over-hasty attitude. For example, p. 55: "As a matter of actual fact, such transitions have never been observed and cannot correspond to a stable equilibrium between the phases". (The type of transition referred to is a second-order transition as defined by Ehrenfest.) It is very hard to reconcile the first part of this sentence with the observed specific heat curves associated with the onset of superconductivity and with the transition of liquid helium. A definite refutation of the second part has been given by Bridgman[1].

The Lennard-Jones and Devonshire theory of melting is apparently criticized (p. 111) on the ground that the entropy-temperature curves (plotted at constant pressure) show a monotonic increase instead of being S-shaped. The answer to this is simply that the entropy-temperature curve consists of *two distinct* branches, corresponding to the two valleys in the surface depicting free energy as a function of volume and temperature. The process of melting at constant pressure consists of a transition from one branch to the other, and the melting temperature is determined by the usual condition that the Gibbs function must be the same for both phases.

Throughout most of the book, the author treats a liquid as having a structure akin to that of a solid the long-range order of which has been lost. Chapter 1 therefore starts by considering various possible processes by which 'holes' can appear in a crystal, and lattice imperfections can diffuse through it. The length of this chapter seems excessive, as it seems to do little more than establish that the probability of such processes is governed by a factor of the type $e^{-W/kT}$, and to suggest various means of roughly estimating W. Chapter 2 contains a review of some of the theoretical work on order-disorder in alloys and the onset of free rotation in crystals. It is a pity that no mention has been made of the powerful 'quasichemical' method of Fowler and Guggenheim, which enables one to predict, at least approximately, the statistical consequences of very complex physical models which would be very difficult to treat by the older methods, and yet is easy to handle, and is, when applied to simple cases, precisely equivalent to the older theories. The advent of Onsager's work[2] will ultimately necessitate the revision of many of the conclusions of this chapter, particularly those related to the shape of the specific heat curves. It has become clear that the theoretical shape of the specific heat anomaly associated with a co-operative change will be very sensitive to the exact details of the model and to any approximations used in working it out.

Chapter 3 deals mainly with the process of fusion and various criteria for the stability of a crystal lattice, but it also contains an extremely able presentation and criticism of the work of Kirkwood and Prins on the 'structure function' of liquids, the assumptions and approximations that are made in this rather difficult but very important work being carefully pointed out. The discussion of the stability of a line of atoms under specified interatomic and external forces is also of great merit in exhibiting the relationships between the form of the interatomic interaction, the thermal expansion, and of the effect of heating or external forces on the stability of the lattice. An interesting result for the linear model is that it cannot be made stable against both longitudinal and transverse displacements, but this is no longer true for a three-dimensional model. The results are applied to give a rough theory of fusion, but no attempt is made to derive quantitative results.

Chapter 4 deals with the author's theory of viscosity of a liquid, which may be regarded as a generalization of the ordinary theory of elasticity of a solid, the response of a liquid to an external shear being specified by the rigidity modulus, together with a relaxation time specifying the mean life of a molecule in one equilibrium position. Analogous considerations are applied to the compressibility modulus and thus lead to the concept of 'volume viscosity', which is attributed to a relaxation time associated with structural changes in the liquid. From a consideration of the experimental data on absorption of supersonics in liquids it is concluded that the volume viscosity of liquids is large compared with the ordinary viscosity. The alternative explanation, analogous to the well-known theory of dispersion and absorption of sound in gases, is examined and rejected, as, to account for the observed absorption, it would require dispersion at frequencies of the order of 10^8 per sec., which is not observed. The reviewer agrees with this conclusion; but the value of this section would have been much enhanced by a critical summary of the experimental material. Another very interesting section in this chapter deals with the diffusion of gases and solids through liquids, and a reasonable explanation is given of the rather puzzling fact that the diffusion coefficients of different substances are of the same order of magnitude for a given liquid.

Chapter 5 is concerned mainly with the orientation of molecules in liquids, and the work of Debye, Onsager, Kirkwood and others on the problem of the behaviour of polar liquids in an electric field is expounded with great clarity; but here, again, very little experimental material is introduced, and the reader is consequently left in considerable doubt on how much the theories are claimed to explain.

Chapter 6 is mainly a phenomenological discussion of the properties of thin films of liquid and certain allied phenomena. Chapter 7 deals with the fascinating problem of the way in which phase-transitions actually occur. Two of the factors which cause actual transitions to depart from the ideal reversible transition are time-lag in the rearrangement of the molecules, which can lead to a liquid solidifying into the glass-like amorphous state instead of crystallizing, and surface tension. If the surface tension is positive, as it is between a liquid and its vapour, it is possible to superheat the liquid or supercool the vapour far beyond the equilibrium temperature before the transition takes place, because of the difficulty of forming a 'nucleus' of the more stable phase. If, however, the surface tension were negative, the formation of a nucleus would be facilitated, and metastable states would not be possible at all, even under ideal experimental conditions. In fact, no liquid with such a property is known, but it is possible to explain an apparent anomaly connected with fusion. The difference in surface-energies of solid and liquid is always small, but in some cases it is possible to supercool a liquid, and even to superheat a solid, provided that the latter is heated *internally*. Attempts to superheat a solid by heating its free surface invariably fail, however, and it seems that the effect of the free surface is always to lower the energy required to form a nucleus of the liquid phase, and this is what would be expected theoretically.

Chapter 8 deals with the theory of solutions, including those of high polymers, and the properties of rubber-like substances. The author's interests plainly lie in the two latter directions, and the treatment of 'classical' solutions is extremely sketchy, no attempt being made, for example, to expound or discuss the Debye–Hückel theory. The account of the present state of the theory of the behaviour of long-chain molecules seems rather incomplete; for example, no attempt is made to examine the error caused by treating a chain 50–100 'links' long as 'infinite'. Here, again, the lack of a survey of the experimental work on long-chain molecules is acutely felt.

In subjects of this sort, which are in their infancy, the comparison of theory with experiment leads to less clear-cut conclusions than it does in more developed fields of physics. Any theory will, in this field, certainly involve several adjustable constants, and it may well be possible to fit even a wrong theory to most of the facts; but all facts that *cannot* be fitted should certainly be recorded. The fact that this has often not been done detracts somewhat from the merits of a very readable presentation of some far from simple theoretical work. The author never once seems to be carried away by the mathematics, but keeps the essential physical ideas before his reader throughout. H. N. V. TEMPERLEY

[1] *Phys. Rev.*, **70**, 425 (1946).

[2] *Phys. Rev.*, **65**, 117 (1944).

THE BODY'S CHEMICAL MECHANISMS OF DEFENCE*

By Dr. C. R. HARINGTON, F.R.S.

THE defence of the body against the poisonous action of compounds of simple chemical constitution is effected by a variety of chemical reactions. The toxic compound may be oxidized to a non-poisonous product, or to one for which a rapid means of elimination exists. Non-oxidative processes of elimination usually involve conjugation with a normal constituent of the body to give a substance which is relatively non-toxic and is readily excreted. The body shows considerable versatility in the means which it adopts for conjugation of toxic compounds. Examples are the formation of ethereal sulphates from phenols, of glucuronides from phenols and aromatic acids, the combination of organic acids with amino-acids to form products of the hippuric acid type, and the detoxication of halogenated benzenes by linking with acetylcysteine to form mercapturic acids. A certain species-specificity is shown in detoxication by conjugation with amino-acids; thus benzoic acid is combined with glycine to give hippuric acid in all mammalian species so far examined, but in birds it is coupled with ornithine to give ornithuric acid; similarly, phenylacetic acid is detoxicated by conjugation with glycine in man and the chimpanzee, with ornithine in birds and with glutamine in the dog, rabbit, cat and monkey.

The reactions by which detoxications take place occur for the most part in the liver, and their quantitative examination can therefore be made the basis of assessment of hepatic efficiency. This is illustrated by the use of the measurement of hippuric acid excretion following a standard dose of benzoic acid as a liver function test.

Chronic poisoning with a compound which is detoxicated by conjugation may lead to deleterious effects even though the actual conjugating mechanism remains unimpaired. This may happen when the substance utilized by the body for the detoxicating reaction is one which is an essential constituent of the tissues and is at the same time limited in supply. In the case of the mercapturic acid conjugation, the constituent supplied by the body is acetylcysteine, which is a derivative of the essential amino-acid cystine. Since the amount of cystine in the diet is limited, prolonged administration of a compound such as bromobenzene to a growing animal may show its effects by limiting growth, owing to the drain imposed on the supplies of available cystine, in the absence of any signs of direct poisoning by the bromobenzene itself.

Apart from the species-specific utilization of different amino-acids for the detoxication of organic acids, the processes by which the body deals with simple chemical poisons are for the most part group reactions; so that it is possible, from a knowledge of the chemical constitution of a poisonous substance, to predict the probable route of its detoxication.

In protecting itself against invasion by pathogenic bacteria or against the effects of toxins produced by such bacteria, the body adopts entirely different methods.

An attack of an infectious disease frequently produces a condition of life-long immunity to the same illness; immunity of long duration can also be achieved in many cases by vaccination with the killed causative organism, or with products obtained from this organism. In addition to the active state of immunity thus conferred by natural infection or by vaccination, a temporary passive state of immunity can be produced by treatment with the blood serum of an animal which has been infected with the disease or has been vaccinated against it. These facts indicate that the process of immunization calls forth a response in the body which confers upon it powers of defence against subsequent invasions by the same organism; and the phenomenon of passive immunization suggests strongly that these powers are associated with a definite change in the blood of the immune individual.

The fact that the blood is actually altered as the result of immunization can be demonstrated by various reactions in the test-tube. Thus a suspension of infective bacteria, which remains quite stable when mixed with normal blood serum, may be agglutinated when mixed with the serum of an individual immune to the disease caused by the particular bacterium concerned. When the bacterium produces a soluble toxic substance, this will be precipitated and neutralized by the immune serum but not by normal serum. In other instances the bacterium may actually be dissolved by the immune serum. It thus becomes possible to envisage the defence reaction of the body against infection in terms of physical or chemical interaction between a substance newly formed in the blood, which may be designated 'antibody', and the eliciting agent (bacterium or bacterial product), conveniently called 'antigen'.

Although the presence of antibodies in the blood can be demonstrated by a variety of test-tube reactions, there is no real reason to suppose that they are of correspondingly different types. The general features of the antigen-antibody reaction are those of an ordinary colloid chemical reaction (including the zoning phenomenon), and it is more probable that the different physical manifestations of the reaction reflect differences in the physical state of the antigens. All available evidence supports the view that antibodies are specifically altered forms of a definite fraction of the serum globulins.

Antigenic power is not confined to pathogenic bacteria and their products, but extends generally to all proteins which are foreign to the body. Such foreign protein does not act antigenically when taken in the food, because it is broken down by digestion; if, however, it is introduced directly into the deeper tissues of the body it elicits a response similar to that produced by bacteria. There is a considerable variation in the antigenic power of different proteins, the highest activity being found among the proteins of the blood and actively metabolizing tissues, and the least among the highly specialized hormonal proteins.

The power of foreign proteins to act as antigens has been used extensively for the study of the specificity of the antigen-antibody reaction. The method adopted has been to induce known alterations in the protein molecule by the use of reagents which attack the functional groups of the latter. Examples are the use of acid chlorides and azides which react with amino- and hydroxyl-groups, treatment with halogens which enter the benzene ring of tyrosine, and coupling with diazonium salts which again react with tyrosine; the latter method particularly has made it possible to introduce a large variety of new groups into proteins. Study of artificial protein derivatives produced in this way has shown that a new antigenic specificity is conferred by the group introduced, which frequently masks the original specificity almost completely. For example, if an iodinated protein is used as antigen, the antiserum against it will fail to react with the original protein but will react with iodinated proteins in general. A very high degree of specificity is attached to the new group introduced, minor chemical differences such as that between α- and β-glucosides being detectable in the antigen-antibody reaction *in vitro*. If the new group has physiological activity, this may be neutralized by the antiserum in the same way as a toxin is neutralized by an antitoxin.

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* Abstract of the Friday Evening Discourse at the Royal Institution on December 13.

The precipitation of an artificially altered protein by its specific antiserum is inhibited if the antiserum is first treated with excess of the simple chemical compound attached to the protein in the preparation of the antigen. The inhibition occurs because the specific combining sites on the antibody are occupied by the simple compound, and antigen-antibody combination is thus prevented. This inhibition reaction therefore gives reality to the conception that the new groups introduced into artificial protein antigens form actual points of attachment with the antibody, and justifies the designation of such groups as 'haptenes'.

It is now known that among bacteria a situation exists which is similar to that described for the artificially conjugated antigens. Bacteria in general contain complex polysaccharide groups, and it is these groups which confer antigenic specificity ; they are in fact bacterial haptenes, and it is they which determine the structure of the specific antibodies formed against bacteria.

The defence mechanism of the body against bacterial invasion thus consists in the development of antibodies, by virtue of the antigenic power of bacteria due to their content of foreign protein ; the nature of the antibodies is determined by the structure of the bacterial antigen, and in particular by the carbohydrate group of the latter, so that they acquire the specific power of entering into colloidal combination with antigen which they may eventually encounter. The results of the combination, as seen in the test-tube, may be manifold ; but with whatever *in vitro* reaction they are associated, their object, so far as the body is concerned, is protection against the harmful effects of the bacterium or of its products.

The very readiness of the body to react to the introduction of foreign protein, which is essential in the development of defence against bacterial invasion, can itself be an embarrassment. The ordinary defence mechanism which has been described is developed naturally against a continuously increasing amount of antigen, as when invading bacteria undergo multiplication or produce increasing amounts of toxin. Similarly, in artificial immunization, the antigen is usually applied in frequent and increasing doses. If a single small dose of antigenic material is injected into an animal and the latter is left for ten or more days, it passes into a hypersensitive state in which acute toxic effects are produced by a second small dose of the same antigen. The phenomenon is seen in its extreme form in the guinea pig, in which the second dose results in acute bronchial spasm, frequently leading to death of the animal. Accidental sensitization often occurs in human beings, who are, however, much less reactive than the guinea pig ; the analogue of the fatal bronchial spasm (anaphylactic shock) in the latter is the attack of asthma in the individual who has become sensitive to a protein such as that of the dandruff of horse-hair whenever he is exposed to the original sensitizing agent. In general, phenomena of this type are described as allergic, to indicate the altered reaction by which the body responds to contact with a previously harmless substance as if it were a powerful poison ; in addition to asthma, they include the catarrh of hay fever, the nettle rash associated with sensitivity to certain foods, and the dermatitis which results from superficial contact with sensitizing agents and which is perhaps the commonest manifestation of allergy in man.

The nature of many of the substances which induce allergy and the specificity with which they exercise their effects indicate that the allergic phenomenon is essentially an antigen–antibody reaction. On the other hand, it is usually impossible to detect antibodies to the sensitizing agent in the blood of an allergic patient, so that the antibodies must be fixed to certain tissues (such as the bronchial musculature or the skin) which respond by abnormal reaction to contact with antigen.

Allergic phenomena, and particularly dermatitis, are frequently produced by simple chemical compounds unrelated to protein. The explanation of this is that such compounds are either themselves able to react with proteins or are converted in the body into a reactive form. They may thus be designated pro-antigens, since although they are themselves not antigenic they will, when they gain access to the body, react with tissue proteins and so alter these as to turn them into antigens. Pro-antigenic compounds of this type are met with not infrequently ; examples are *p*-phenylenediamine, which is responsible for dermatitis from furs, and the sensitizing principles of *Primula* species and poison ivy (*Rhus Toxicodendron*) which make it impossible for some individuals to touch these plants without acute skin irritation. They occur still more commonly in chemical industry, where they may be a source of serious inconvenience.

In general, allergy may be regarded as being at the same time an illustration of the defensive reactivity of the body against foreign protein and a deviation of the defence mechanism which is actually deleterious.

COUMARIN AS A SELECTIVE PHYTOCIDAL AGENT

By Dr. L. J. AUDUS
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THE recent discovery[1,2] that synthetic plant-growth substances such as 2 : 4-dichlorophenoxyacetic acid have selective phytocidal actions in very low concentrations has opened up a new field of investigation into their mechanisms of action. The search for new molecules with similar properties has been intensified. The fact that unsaturated lactone groupings are frequent features of naturally occurring substances having inhibitive effects on cell-growth[3,4,5] revives interest in the phytocidal activity of the common plant metabolite, coumarin. This substance was, apparently, first shown by Klebs[6] to be toxic to Algæ, and later by Schreiner, Reed and Skinner[7] to have inhibitive effects on the growth of wheat. Cameron[8], in a discussion on soil fertility, referred to the fact that both coumarin and daphnetin prevented the development of wheat, and Sigmund[9] noted the effects of daphnetin and æsculetin on seed germination. In 1934, Köckemann[10] gave the term 'blastocholine' to material of unknown structure, present in ripe fruits, which suppressed germination of cress seeds. Since then it has been shown[11,12,13] that a number of unsaturated lactones, including coumarin, parasorbic acid and β-angelicalactone have blastocholine effects, suppressing germination of seeds at concentrations such as 100 parts per million. The concentrations at which the lactones are effective have been considered to be much higher than those which bring about comparable effects with 2 : 4-dichlorophenoxyacetic acid.

Selective Phytocidal Action of Coumarin

In view of these facts, we decided to set up experiments, with a number of plant species, to investigate the possible activity of coumarin as a selective phytocidal agent. Comparisons were made of the effects of coumarin with those of 2 : 4-dichlorophenoxyacetic acid on the same species of plant. A water culture technique was employed. 15 ml. portions of standard water culture solution (the same as that of Nutman, Thornton and Quastel[1] was used, with the omission of potassium nitrate) containing various dilutions of the phytocidal agent were placed in $\frac{5}{8}$-in. test-tubes, and 'thimbles' of glass wool were then pushed down the tubes until they just touched the surface of the medium and became soaked by it by capillary action. These 'thimbles' stayed firmly in place in the tubes during all subsequent handling, and were found to be very efficient supports for the seeds. They ensured optimum aeration and constant contact with the medium, and in addition, the radicles could easily grow through the fine sieve-like meshes into the culture medium itself. The tubes were plugged and then autoclaved, and all seeds were surface-sterilized with 80 per cent alcohol and dilute mercuric chloride[1] before sowing in the tubes. Samples varied in number from 30 to 100 seeds per tube, depending on the species under consideration. The need for thorough sterilization of culture media and surface sterilization of the seeds had been made obvious to us in preliminary experiments with indolylacetic acid. This substance, which shows high phytocidal activity in sterile media[1] at a concentration of one part in ten million, loses its activity in unsterilized media, owing to vigorous bacterial attack. Precautions concerning sterility were therefore taken in testing the phytocidal activities of all plant-growth substances used in small concentrations.

Seeds were allowed to germinate for 1–2 days in the dark and then grown in normal daylight at 20° C. When the roots of the 'control' seedlings had reached a suitable length (generally after about 7–10 days growth) the experiment was stopped. The roots of all sets of seedlings of a series were cut off with a sharp scalpel, dried rapidly on blotting paper, and were then weighed rapidly and accurately to the nearest 0·1 mgm. This final weight of root has been taken as the measure of growth for estimation of the phytocidal action of the substances concerned. It has been shown, for 2 : 4-dichlorophenoxyacetic acid and other similar agents, that root-growth is the most sensitive and consistent measure of their effects. In addition, the percentage germination was also determined in each case.

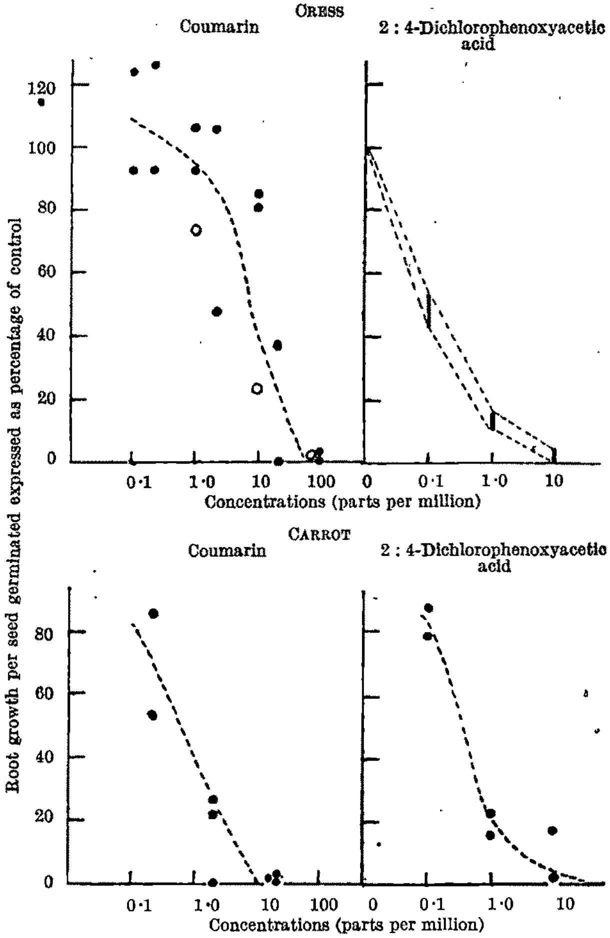


Fig. 1. EFFECTS OF SOLUTIONS OF VARIOUS CONCENTRATIONS OF COUMARIN AND 2 : 4-DICHLOROPHENOXYACETIC ACID ON THE ROOT-GROWTH OF SEEDLINGS OF CRESS AND CARROT

Figs. 1 and 2 show typical results for two of the species investigated, cress and carrot. In order to separate so far as possible the two physiological effects, namely, on germination and on the subsequent root-growth, root weights have been calculated as a sample average per seed germinated. In Fig. 1 these values are expressed as percentages of those in the control tubes in each case. A large amount of data has been accumulated (approximately twenty experiments) on the effects of 2 : 4-dichlorophenoxyacetic acid on root growth of cress, and in the relevant graph the growths are plotted as vertical lines about the mean value. These lines have a range equal to the standard error on either side of the mean.

From the two sets of graphs the following main points stand out:

(1) Coumarin exerts a dual effect, namely, a marked inhibition of both germination and root-growth subsequent to germination. Root-growth is slightly more susceptible than germination. In contrast to this, 2 : 4-dichlorophenoxyacetic acid shows no significant effect on germination over the range of concentrations used, although root-growth is reduced to very low values in the highest concentrations of 10 parts per million.

(2) The action of coumarin is a differential one, carrot being about twenty times as sensitive as cress, whereas these two plants appear to be equally sensitive to 2 : 4-dichlorophenoxyacetic acid.

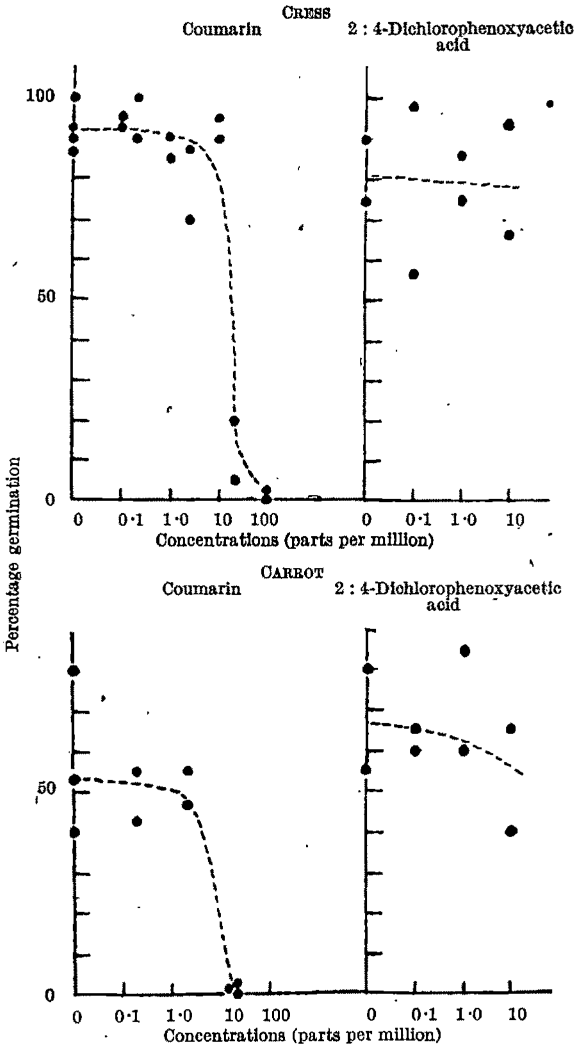


Fig. 2. EFFECTS OF SOLUTIONS OF VARIOUS CONCENTRATIONS OF COUMARIN AND 2 : 4-DICHLOROPHENOXYACETIC ACID ON THE GERMINATION OF CRESS AND CARROT

In all, nine widely different species of plant have been tested. From graphs similar to those of Figs. 1 and 2, the accompanying table has been drawn up showing the concentrations in parts per million of coumarin and 2 : 4-dichlorophenoxyacetic acid necessary to reduce the root-growth and the germination to 50 per cent of the control values in each species.

Species	50% inhibition of root growth		50% inhibition of germination	
	Coumarin (p.p.m.)	2 : 4-Dichlorophenoxyacetic acid (p.p.m.)	Coumarin (p.p.m.)	2 : 4-Dichlorophenoxyacetic acid (p.p.m.)
Cress	11	0·2	11	Greater than 10 in all cases
Radish	8	0·6	10	
Mustard	8	0·15	>20	
Carrot	0·5	0·3	5	
Onion	15	0·3	>20	
Mixed lawn grass	4	>10	4	
Beetroot	12	0·11	>20	
Taraxacum officinale	10	6·0	6	
Cabbage	50	0·04	4	

From this table it will be seen that coumarin exerts the same order of differential action as 2 : 4-dichlorophenoxyacetic acid itself, although on the average, so far as root-growth is concerned, it is between a tenth and a hundredth as effective. In addition, the differential action does not run parallel; for example, whereas cabbage and cress are most sensitive to 2 : 4-dichlorophenoxyacetic acid, they are least sensitive to coumarin. Grass, on the other hand, is more sensitive to coumarin than to the other compound. Carrot is equally sensitive to both.

Formative Effects

Experiments on a number of dicotyledonous species have shown that continued growth of certain species in concentrations of 2 : 4-dichlorophenoxyacetic acid of the order of 1–10 parts per million gave rise to characteristic formative effects on the base of the hypocotyl. This is shown very markedly in radish and to a lesser extent in cress and carrot, where the lower half of the hypocotyl swells to two or three times its normal diameter and becomes translucent in appearance. The histological changes concerned in this are now under investigation. It is interesting to note that coumarin, in concentrations giving the same degree of inhibition of root-growth, also gives similar formative effects on the hypocotyl.

Action of Coumarin in Soil

In addition to experiments in sterile water culture, others have been set up in soil. Small glass pots with a basal vent were filled with air-dry garden soil and then saturated with coumarin solutions of various concentrations (1, 10 and 100 p.p.m.) and allowed to drain. Seeds of the above-mentioned species were then sown in a series of concentrations as in the water-culture experiments, and allowed to germinate. Subsequent watering of the soil was with distilled water, care being taken not to wash out the coumarin with excess water.

Germination and growth gave the same general picture of the effect of coumarin as in the test-tube experiments, but there seemed to be a general all-round reduction in its effectiveness. In addition, seeds, the germination of which had been inhibited in the high concentrations of coumarin, eventually germinated after a lag period of about five days. Subsequent growth was as in the control. It seemed therefore that coumarin, like heteroauxin (β-indolylacetic acid), may be destroyed in soil, and that its inhibition of germination is reversible.

Coumarin Breakdown in Soil

Experiments have been carried out with the assistance of Mr. P. G. Scholefield of this Unit on the breakdown of coumarin in soil, and these will be reported upon in detail in due course. The procedure and results are, briefly, as follows:

A saturated solution of coumarin (100 p.p.m.) was circulated through soil in a soil perfusion apparatus[14] and its rate of disappearance from soil was investigated using a sensitive colorimetric method for the estimation of coumarin. It was found that, following an immediate adsorption of part of the coumarin on the soil, a microbiological attack takes place, and the coumarin disappears completely from the soil, under the given experimental conditions, within forty-eight hours. Certain bacterial poisons inhibit the breakdown of coumarin in soil, and investigations are now being carried out to see if the addition of

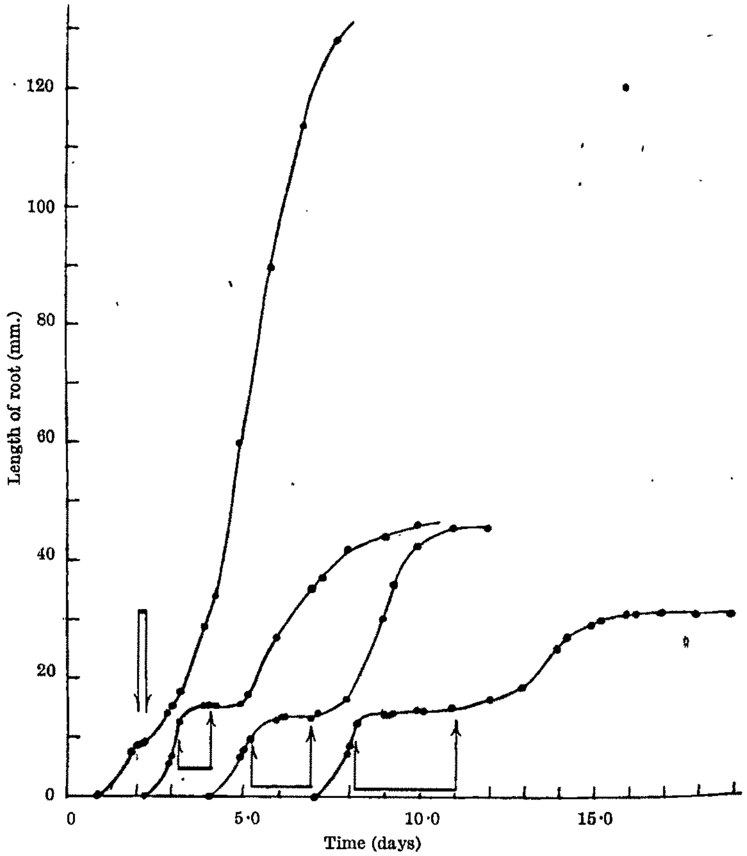


Fig. 3. CURVES SHOWING THE REVERSIBILITY OF THE ACTION OF COUMARIN ON THE GROWTH OF ROOTS OF CRESS. THE POINTS OF ORIGIN OF THE INDIVIDUAL CURVES (THAT IS, TIMES OF COMMENCEMENT OF THE EXPERIMENTS) ARE SPREAD OUT ALONG THE TIME AXIS TO AVOID CONFUSION

such poisons to soil will render coumarin more effective as a phytocidal agent under soil or field conditions.

Reversibility of Action by Coumarin

It is clear that for any understanding of the mode of action of such phytocidal agents as 2 : 4-dichlorophenoxyacetic acid and coumarin, it is essential to know if their inhibitive effects are reversible. If these compounds have toxic effects because they combine in an irreversible manner with cell constituents, their effects will be irreversible, and washing the plant tissue to remove the toxic agent will not result in renewed growth of the plant. On the other hand, if these agents act by forming easily dissociated compounds with tissue constituents, whether they are enzymes or metabolites, washing the plant tissue to remove the toxic agent should result in renewed growth of the plant, so long as autolytic processes have not advanced too far during the interval of time in which growth has not taken place.

We have carried out experiments on the reversibility of action of 2 : 4-dichlorophenoxyacetic acid and of coumarin, and it is clear that, with both substances, reversibility does take place. We propose to give the results of experiments with coumarin, while the details of the work with the other substance will be reported upon later.

Two types of experiment were carried out :

(1) *Reversibility of inhibition of germination.* Cress seeds were soaked in saturated coumarin solution and stood aside in the dark. At intervals of twenty-four hours, the seeds were removed and supported on the surface of a constant, slow-running stream of water-culture solution. Control seeds germinated twenty-four hours after soaking at 20° C. Seeds removed from the coumarin solution after 1, 2, 3 and 4 days, and then washed, all germinated about 36–48 hours after washing, with subsequent normal growth. Longer exposure to coumarin solution of this concentration resulted in complete destruction of the germinative capacity of the seeds.

(2) *Reversibility of the inhibition of root-growth.* In addition to experiments on germination, observations were made on the reversibility of coumarin action on the growth of cress roots. In these experiments, individual seeds were germinated and grown in an aerated water-culture solution which was constantly circulated over them, and the growth of roots was followed by means of a travelling microscope reading to 0·02 mm. Full details of the apparatus and methods will be published in a later paper.

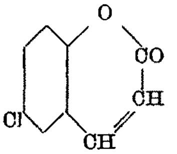
It was found that the addition of coumarin to the circulating solution has the same effects on the growth of individual roots as those observed by the test-tube technique. The open circles in the first graph of Fig. 1 show the values obtained by this method. Experiments were carried out by exposing the root to a circulating culture medium containing 100 p.p.m. of coumarin for varying periods of time and then replacing with pure culture solution. The graph of Fig. 3 shows typical effects of this procedure on the growth of roots of cress. The pairs of vertical arrows mark the duration of the exposure to coumarin in each case (in this experiment 6, 22, 40 and 68 hours). It will be seen that 100 p.p.m. of coumarin gradually reduced the growth-rate to zero during a period of 12–18 hours, and that replacing in fresh circulating culture medium brings about partial recovery. The degree of this partial recovery seems directly correlated with the time of exposure to the coumarin.

Insufficient experiments have been carried out, so far, to do more than make it clear that when a seedling has ceased to grow in coumarin solution for periods up to two or even three days, recovery can take place. It is scarcely to be expected that the recovery will be more than partial; first, because it is unlikely that washing, however good, will remove all the toxic agent, and secondly, because, during the period in which growth is not occurring, autolytic processes must be taking place to the detriment of the subsequent growth. Studies of the chemical events occurring in the plant during the period of inhibited growth should help to throw light on the chemical mechanisms underlying the action of the phytocidal agents. Further experiments have shown that recoveries from the inhibitive effects of coumarin or 2 : 4-dichlorophenoxyacetic acid may be more complete in certain plant species than in others.

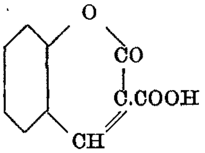
Effects of Coumarin Derivatives

Two derivations of coumarin have been synthesized by Mr. P. G. Scholefield and have been tested to see if they have phytocidal activities. They are:

(i) Monochlorcoumarin



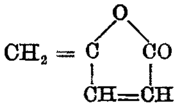
(ii) Coumarin-carboxylic acid



Tested on the carrot, monochlorcoumarin has about one twenty-fifth the inhibitive effect of coumarin on the growth-rate, and one quarter the inhibitive effect of coumarin on the germination. The coumarin-carboxylic acid has about one half the inhibitive activities of monochlorcoumarin. These results make it clear that the presence of substituents may greatly affect the phytocidal activity of the unsaturated lactone ring. Moreover, they emphasize the contrast between coumarin and phenoxyacetic acid, for in the latter the introduction of a chlorine atom into the benzene ring results in increased phytocidal action.

Protoanemonin and Ranunculin

We have been able to carry out experiments with ranunculin (kindly supplied to us by Dr. R. Hill), the diglucoside of protoanemonin, and with protoanemonin itself



as possible phytocidal agents.

Preliminary experiments have shown that protoanemonin is much more effective, and ranunculin is slightly less effective, than coumarin in suppressing the root-growth and the germination of cress.

Conclusions

The most important fact which emerges from this work is the dual nature of the phytocidal activity of coumarin; namely, inhibition of both germination and subsequent root-growth. With respect to the inhibition of root-growth, one feature of the activity of coumarin is its broad similarity to the action of 2 : 4-dichlorophenoxyacetic acid and other phytocidal agents of the heteroauxin class. Although it is only active in this respect at relatively high concentrations (of the order of 10 parts per million), its differential effects are just as clearly defined as, and its formative effects are apparently identical with, those of 2 : 4-dichlorophenoxyacetic acid. Moreover, in the case of at least one plant, carrot, the inhibitive effects of coumarin at a concentration of one part in two millions are as great as those of 2 : 4-dichlorophenoxyacetic acid.

With respect, however, to the inhibitive effects on germination, coumarin is much more active with certain plants than 2 : 4-dichlorophenoxyacetic acid, which in the highest concentrations used (10 parts per million) has no suppressing effects on germination. The two substances also differ in that their differential effects do not run parallel.

The inhibitive effects of coumarin are reversible, and extensive observations (to be reported) with cress and garden pea show that the action of 2 : 4-dichlorophenoxyacetic acid is also reversible. The facts indicate that these substances must effect their inhibitions by forming loose combinations, or easily dissociated compounds, with enzymes or metabolites in the plant cell.

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AN ARMAGH–DUNSINK–HARVARD TELESCOPE

By Dr. E. M. LINDSAY
Director of Armagh Observatory

PLANS for the setting up of a Baker–Schmidt telescope on the site of the Boyden Station of the Harvard Observatory, Bloemfontein, South Africa, are now complete. It will be the first instrument of its kind in the world, and will also be a noteworthy example of inter-country international co-operation. The instrument will be operated jointly by the Armagh Observatory, Northern Ireland; the Dunsink Observatory, Dublin, Eire; and the Harvard Observatory, Cambridge, U.S.A. It will be known as the Armagh–Dunsink–Harvard Telescope. The Governments of Northern Ireland and of Eire have each promised to contribute £5,000 towards the cost of the new instrument, and Harvard Observatory will provide the rest of the funds. Harvard will also provide appropriate caretaking and maintenance service, the necessary power and light for the proper operation of the instrument, and access to library and dark-rooms for all observers. The observing time with the instrument will, however, be shared equally by all three Observatories.

The main mirror of the new telescope will be of 36-in. aperture, the secondary mirror of not less than 16-in. and the correcting plate of not less than 30-in. diameter. The famous 24-in. Bruce refractor of the Harvard Observatory will be dismantled, and its mounting and drive will be used for the Baker–Schmidt. It is expected that the new reflector will be about three times as fast as the Bruce. The present 24-in. prism of the Bruce will be re-figured, or a new objective prism manufactured.

Four months of observing in South Africa should provide for each observer approximately three years of research. Thus an observer need spend only about ten per cent of his time away from his own Observatory. The new telescope will require an increase of staff at the Armagh Observatory. To provide for this, the Government of Northern Ireland has promised to give an increased annual grant to the Observatory. The Government of Eire has taken over Dunsink Observatory, which will be re-opened and will be incorporated in a new school of cosmic physics attached to the Dublin Institute of Advanced Studies.

The new Armagh–Dunsink–Harvard telescope will help to fill the long-felt need for more observational material from the southern hemisphere. It will be ideally suitable for such varied problems as galactic structure, variable stars, spectrophotometry, standard photometry, galactic nebulæ, external galaxies and, possibly, statistical radial velocities.

Harvard will be responsible for the design of the reflector, and the Perkin–Elmer Corporation, Glenbrook, Connecticut, has already started on its manufacture. It is hoped that the instrument will be in operation within eighteen months.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES

AFTER an interval of nine years, the International Committee of Weights and Measures held its first plenary session since 1937 during October 22–29, 1946. The meetings of the Committee which should have taken place in 1939 could not be held owing to the outbreak of war, and the only other meeting which has been possible in the meanwhile was an unofficial one of a few members in 1945 to prepare the way for the recent session. By its constitution, the members of the Committee, which functions under the authority of the treaty known as the "Convention du Mètre", must all be of different nationalities. On this occasion the members present were MM. Louis de Broglie (France), G. Cassinis (Italy), M. Chatelain (U.S.S.R.), E. C. Crittenden (U.S.A.), M. Dehalu (Belgium), W. J. de Haas (Holland), E. S. Johansen (Denmark), W. Kösters (Germany), Z. Rauszer (Poland), M. Ros (Switzerland) and J. E. Sears (Great Britain), together with M. A. Pérard, director of the Bureau International des Poids et Mesures.

The Committee had first to record, with deep regret, the deaths, since its last meeting in 1937, of six former members: MM. B. Cabrera (Spain), Ch. Fabry (France), D. Isaachsen (Norway), A. E. Kennelly (U.S.A.), V. Volterra (Italy) and P. Zeeman (Holland). In the passing of six such distinguished men of science from its numbers, including both its president, M. Volterra, and secretary, M. Cabrera, the Committee has suffered a very severe loss. No news has been received of Prof. Nagaoka, the Japanese member, since 1939, and it is not at present known if he is still alive.

Mr. J. E. Sears was elected president for the current session, and M. Dehalu was elected secretary. M. Pérard presented, and briefly outlined the main features of, his report on the activities of the Bureau International for the period September 1, 1939–August 31, 1946. This was referred for more detailed study to two sub-committees, the Commissions des Travaux, and des Finances, respectively.

The Committee reviewed and confirmed the decisions taken provisionally by the unofficial meeting in 1945. A letter was then read from the French Government asking that, for the future, the Conservatoire des Arts et Métiers should be regarded as the French National Metrological Laboratory, eligible to nominate technical experts, on the invitation of the International Committee, to serve on its Advisory Committees for Electricity, Photometry and Thermometry. This was agreed to.

At their second meeting the members of the Committee made the usual formal visit of inspection to the vault at the Bureau, where the International Prototype Metre and the International Prototype Kilogramme are preserved. They were able to see the reinforcement which had been built into the vault to protect it from the possible shock of bombardment, and noted with satisfaction that, although several bombs actually fell in the grounds of the Bureau, no damage whatever occurred to any of the invaluable standards contained in the vault.

The Committee then proceeded to the consideration of the Report of the Commission des Travaux on the work of the Bureau during the past seven years. It is satisfactory to be able to record that, in spite of difficulties arising from war conditions, the Bureau has been able to make good progress with its programme. In particular, new sections for the comparisons of electric and photometric standards have been installed to deal with the additional duties entrusted to the Bureau following the revision of the Convention du Mètre in 1921.

The Report contains an interesting account of the re-comparison—the first since its original adoption in 1889—of the International Kilogramme with its *témoins*—the working standards of the Bureau. The results obtained agreed with those found in 1889 within 0·05 mgm. in every case, and within 0·01 mgm. in the mean. This, however, was only attained after special cleaning of the weights, first with chamois leather, moistened with benzine, and then with a jet of steam. Prior to this treatment the maximum change recorded was 0·083 mgm., with an apparent increase in the mean value of the *témoins*, relative to the International Kilogramme, of 0·045 mgm.

Improvement has been effected in the accuracy of comparison of the metre standards (*a*) by re-engraving some of those (other than the International Metre itself) which had defining lines inferior to the best attainable by modern means, and (*b*) by the introduction of microscopes on the comparator adapted to rotate about their axes so that the effects of any asymmetry in illumination can be eliminated. It is claimed that as a result of these measures the accuracy of comparison of two metre standards is now within ±0·1 micron. The working standards of the Bureau, which were dispersed for safety during the War, have been re-compared, with results agreeing within this figure with their former values. The possibility of adopting a unit of length defined in terms of a wave-length of light was discussed, but further experimental work is considered necessary before final effect could be given to this proposal.

A proposal that the Bureau should undertake a new determination of the value of gravity, by direct cinematic observation of a freely falling body, was approved by the Committee. A further suggestion, to undertake a new determination of the velocity of light, was negatived on the ground that it was considered to be outside the terms of reference of the Bureau.

The Report of the Commission des Finances showed that the accounts of the Bureau had been properly kept. A number of States, particularly those which have been in enemy occupation during the War, are in arrears with their subscriptions, and the Committee discussed the steps necessary to regularize the position. The present arbitrary rate of exchange of the French franc has been a cause of difficulty to the Bureau, and a recommendation to ask the next Conférence Générale for an increased rate of subscription was accepted by the Committee.

The Committee then proceeded to a consideration of the membership of the three advisory committees. In addition to the Conservatoire des Arts et Métiers, to which reference has been made above, the national laboratories invited by the International Committee to appoint representatives on these committees are: the Bureau of Standards, Washington; the Institut de Metrologie, Leningrad; the Laboratoire Electrotechnique, Tokyo; the National Physical Laboratory, Teddington; and the Physikalisch-Technische Reichsanstalt, Charlottenburg. Further, three independent specialists in the respective subjects, together with the presidents of these committees, are directly nominated by the International Committee. M. Chatelain having declined the office on the ground that he lived too far away from Paris, Mr. Sears was elected president of the Advisory Committee for Electricity. Mr. Crittenden was elected president of the Advisory Committee for Photometry, and M. de Haas president of the Advisory Committee for Thermometry. M. Lombardi was re-elected a member of the Advisory Committee for Electricity, and it was agreed that the International Electro-technical Commission should be consulted as to the two remaining vacancies. Messrs. Bordoni (Italy), Pirani (Germany) and Zwikker (Holland) were re-elected to the Advisory Committee for Photometry, and Messrs. Perucca (Italy), Timmermans (Belgium) and Zwietosławski (Poland) were elected to the Advisory Committee for Thermometry.

The most important business before the International Committee arose from the recommendations of the advisory committees at their previous meetings in June 1939, in particular, that absolute electrical units, based on the M.K.S. (or the C.G.S.) system, should be substituted for the present international electrical units, based on the mercury ohm and the silver voltameter, and that a new unit of candle-power, based on the luminous intensity of a black-body radiator at the temperature of solidification of melted platinum (60 units per cm.^{2}), should be substituted for the present international candle, as from January 1, 1940.

As the International Committee had not met since these recommendations were made, it had not been possible to implement them at the date proposed. The Committee, having already been empowered to that effect by the General Conference of 1933, has now decided that these proposals should be put into force as from January 1, 1948, and notification of this decision is being sent to the Governments of all the States subscribing to the Convention. No difficulty arose with regard to the new unit of candle-power which, it is understood, has already been adopted in Germany. The decision in this case was unanimous. With regard to the proposed change in the electrical units, objection had been raised by the Physikalisch-Technische Reichsanstalt; but the Committee held that it was important that the decision on this question should not be further delayed, as unless the change were to be made soon it was likely to become increasingly difficult to make it at all. In this case the decision was that of a majority, with one dissentient.

The ratios of the principal international to the corresponding absolute electrical units accepted by the Committee are:

1 mean international ohm = 1·00049 ohm (absolute).

1 mean international volt = 1·00034 volt (absolute).

The recommendation of the Advisory Committee for Thermometry, that the calorie should be defined directly in terms of the joule, instead of by reference to the specific heat of water, was regarded as of less urgency and, as some objection had also been received to this proposal, it was agreed to defer a decision on it until the Advisory Committee had had a further opportunity of considering it.

OBITUARIES

Sir John Flett, K.B.E., F.R.S.

By the death of Sir John Smith Flett, British geology has sustained the loss of one of its most distinguished exponents, with an established reputation both at home and abroad. His career affords a remarkable example of the original research worker and able administrator, and his place is assured in the long line of distinguished geologists who have directed the work of the Geological Survey and Museum during the last 111 years.

Flett was born in 1869 in Kirkwall, Orkney, and was educated at Kirkwall Burgh School, then at George Watson's College, whence he proceeded to the University of Edinburgh. His academic career was prophetic in its brilliance and versatility, and was marked by the award of a unique and imposing array of prizes, medals and scholarships in the Faculties of Arts, Science and Medicine. He graduated M.A., B.Sc. (with honours in natural science) in 1892, M.B., C.M. in 1894, and spent a short time in medical practice. The urge towards geological work, however, was strong within him, and in 1895 he accepted the post of assistant to the professor of geology (then James Geikie) in Edinburgh, and very shortly afterwards was appointed lecturer in petrology. Concurrently with that post he held lectureships in geology at the Heriot-Watt College, the East of Scotland School of Rural Economy, and the School of Forestry in the Royal Botanic Garden. There followed six strenuous years of teaching, lecturing and research work resulting in part in the publication of two outstanding papers, "The Old Red Sandstone of the Orkneys" and "The Trap Dykes of the Orkneys", accepted in 1899 by the University of Edinburgh as a thesis for the D.Sc. degree.

Flett's reputation as a geologist and petrographer was steadily growing, and when, in 1901, the late Sir Jethro Teall relinquished the post of petrographer to become director of the Geological Survey and Museum, the young man from Scotland was offered and accepted the vacancy. He speedily made his influence felt. Familiar with the most recent methods of research, a skilled mineralogist, widely read in the literature of his subject, and possessed of energy, enthusiasm and a formidable capacity for constructive work, he set in motion a continuous flow of published reports, papers and contributions to official memoirs which permanently enhanced the reputation of the service to which he belonged. He attracted to his laboratory many of the younger Survey men of his time. These he trained in his methods, and inspired and encouraged not a few of them to original research and subsequent distinction within and without the Survey. The output of his scientific work during this period was truly remarkable, comprising as it did petrographical contributions to no fewer than thirty official memoirs, the classic "Report on the Eruptions of the Soufrière in St. Vincent, in 1902, and on a visit to Montagne Pelée, in Martinique" (with Tempest Anderson), "The Geology of the Lizard and Meneage" (with J. B. Hill), and numerous contributions to scientific journals some of which were written in collaboration with his colleagues. In addition he contributed eighty-three petrological articles to the "Encyclopædia Britannica" (11th edition, 1910), and it is noteworthy testimony to the soundness and permanence of his work that thirty-three of these contributions appear in the 14th edition (1929).

In 1911 Flett succeeded the late Dr. John Horne as assistant to the director in Scotland, and thereafter became more and more immersed in Survey business and administration. He took an active and personal interest in every branch of Survey work, made extended visits to the field and familiarized himself with the numerous problems which constantly arise in the production and publication of geological maps and memoirs. The outbreak of war in 1914 caused serious depletion of the Survey staff, many of whom volunteered and were accepted for active service, and at the same time imposed on the directorate new tasks and responsibilities in the search for, and assessment of, available resources of raw materials in short supply, and in meeting insistent demands for geological information relating to the sites of camps, training centres, aerodromes and factories at home and to military operations overseas. Flett tackled these new tasks with characteristic energy. He not only organised and directed the Scottish section of the work but also undertook a considerable amount of field investigation and made substantial personal contributions to the numerous reports prepared for the information of service and supply departments. His reputation as geologist, petrographer and administrator was now firmly established and fully justified his selection in 1920 to succeed the late Sir Aubrey Strahan as director of the Geological Survey and Museum, a post he filled with conspicuous distinction and success for fifteen years.

The record of achievement of the Geological Survey and Museum during this period is an impressive one. The arrears of work, an inevitable legacy of four years of war, were rapidly overtaken, the staff was enlarged and reorganised, district offices were established in the coalfields, and the work of bringing up to date and publishing the geological information relating to these vitally important areas was prosecuted with an unprecedented vigour and resulted in a steady outflow of maps, memoirs and special reports. Nor were the purely scientific aspects of geology neglected. The surveys of the great volcanic complexes of Mull and Ardnamurchan were completed and the results embodied in maps and memoirs which stand unrivalled as classic records of perhaps the most complicated structures ever mapped by the Geological Survey. Similarly, the extensive complexes of schist and granite of central and northern Sutherland were mapped and described, and the field survey of the Orkney and Shetland Islands was completed.

Throughout this period of strenuous activity Flett steadily pursued the scheme, proposed in 1912 by the Bell Committee, for the transference of the Geological Survey and Museum from the inadequate and congested accommodation in Jermyn Street to a new and more spacious building in South Kensington. The culmination of his efforts came in July 1935, when the King (then Duke of York) formally opened the new Geological Museum and Survey offices in Exhibition Road, and the institution, served so long, so devotedly and to such purpose, celebrated its centenary. Two months later Flett retired from the public service. In his retirement he continued with characteristic energy his geological pursuits and his deep interest in all matters connected with the Survey and Museum. He saw through the press his memorial volume, "The First Hundred Years of the Geological Survey", written during the last period of his directorship, revised the Lizard map and prepared a second edition of the memoir now being printed, and took the greatest pleasure in stimulating his colleagues and "his young men" to fresh endeavour for his beloved science. Active to the end, he died with startling suddenness in the garden of his cottage at Ashdon, Essex, on January 26.

Many honours came to Flett in the course of his long and brilliant career. He was a fellow of the Royal Societies of London and Edinburgh, Bigsby and Wollaston Medallist of the Geological Society, LL.D. of his own University, created K.B.E. in 1925, president of Section C of the British Association in 1921, president of the Mineralogical Society, and member and correspondent of numerous societies in the Dominions and foreign countries where he had travelled extensively. But what he valued most of all was the satisfaction of endeavour and achievement, and his name is permanently woven into the fabric of Survey history and tradition as a great geologist and a great director. W. F. P. McLintock

Prof. George L. Funke

Prof. George L. Funke, professor of botany in the University of Ghent, died on December 15 at the age of fifty, after an operation. He was Dutch, born at The Hague on May 29, 1896, and was educated at Amsterdam and Utrecht. He graduated at the University of Utrecht in 1922 with a doctorate in botany and zoology. After some years as lecturer in Holland, he went in 1934 to Belgium as a lecturer at the University of Ghent, where he became an ordinary professor in 1937; during the War and the German occupation of Belgium, he was forced to go back to Holland, being deprived by the Germans of his post, which he resumed, however, in 1945.

Prof. Funke, who was unmarried, displayed an uncommon energy and an almost youthful enthusiasm in every kind of activity he took up; as director of the Botanical Laboratories at the University of Ghent, he paid much attention to the practical side of his work, and defended, at times against powerful odds, the teaching of biology in schools. His purely scientific work was of importance, particularly with regard to the question of the influence of the light on plant development. Inspired by the investigations of Dr. Fröschel, he developed a new branch of botanical science which may be called 'experimental plant sociology'; a book on this subject, it is expected, will shortly be published in the United States.

P. van Oye

Dr. Victor Robinson

THOSE who had known Victor Robinson only through his writings were unwilling at first, when they met him face to face, to associate this modest, hypersensitive, and extremely genial little man with so dramatic, fiery and sentimental a pen. Nevertheless, as a historian he was painstakingly accurate, being most scrupulous in going to the original sources.

The son of a medical man, Robinson was born in the Ukraine on August 16, 1886, emigrating to the United States of America in infancy. One of the first to specialize in the history of medicine in that country—he used to confess that his interest in the subject gave him the same sort of satisfaction as the devotee of hasheesh derives from his pipe—in 1912 he published one of his best known and most popular books, "Pathfinders in Medicine", for which he was hailed as the "Poet of Science". Eight years later he founded *Medical Life*, stated to be the first monthly journal of medical history in the English language. Specializing in valuable medico-historical symposia, at one period it served as the official organ of the American Society of Medical History. Beginning with the October 1922 issue the section on clinical medicine was eliminated. Its editorial board included such distinguished historians as Castiglioni, Comrie, de Lint, Ebstein, Neuburger, Sigerist, and Sudhoff. Robinson's last book, "Victory over Pain : a History of Anesthesia", was published in New York late last year, and it is interesting to be reminded that the author's first contribution to the literature of medical history was an article on "Simpson on Chloroform", and that his name was first listed in the "Index Medicus" under the heading of "Anesthetics".

Robinson was professor of the history of medicine at Temple University Medical School, Philadelphia, and lecturer on the history of nursing. He occupied a delightful apartment in New York's Greenwich Village. His medico-historical library was enviably complete, making him more or less independent of the City's reference libraries. Though an apparently facile writer, he was a tremendously hard worker, the German word *Sitzfleisch* being often on his lips. One of his most novel and entertaining essays appeared in the *Medical Review of Reviews* in 1929, describing his experiences with the fluid extract of hasheesh. In the introduction to "Pathfinders in Medicine", Victor Robinson characteristically admitted having entered the field of medical history as he had entered several others—out of curiosity. "But the fruit was tempting, and I have gathered it ever since."

W. R. BETT

NEWS and VIEWS

An International Trust for Zoological Nomenclature

IN view of the rapid growth in recent years in the volume of its work, the International Commission on Zoological Nomenclature (which is an unincorporated body of eighteen international commissioners elected by the International Zoological Congress) recently decided that an incorporated body should be formed for the purpose of managing its financial and other business affairs. For this purpose a body has now been incorporated under United Kingdom law with the title "International Trust for Zoological Nomenclature". At the same time an agreement has been made between the International Commission and the International Trust by which the Commission has transferred its assets to the Trust and the Trust has accepted responsibility for all the liabilities of the Commission. Under the new arrangements, the Commission will continue all its scientific functions, while the Trust will be responsible for publishing the Commission's "Opinions" and other publications, for meeting the administrative expenses of the Commission, and for carrying out such further developments as may be decided upon by the Commission. The full text of the instrument of incorporation will be published as soon as possible in the Commission's "Bulletin of Zoological Nomenclature".

The closest liaison between the Commission and the Trust is assured by arrangements under which the members of the Commission will be members of the Trust, and the secretary to the Commission will be *ex-officio* secretary to the Trust. In addition, the Trust has taken over, as its registered office, the premises at 41 Queen's Gate, London, S.W.7, hitherto occupied by the Commission as its publications office. In order to ensure that there shall at all times be a sufficient number of members available to attend meetings of the Trust, the Commission has arranged for the appointment as members of the Trust of certain of the honorary unpaid officials of the Commission. At the invitation of the Commission, the chairmanship of the Trust has been accepted by the Right Hon. Walter Elliot. The arrangements outlined above will provide the Commission with a strong administrative organisation and also enable it to concentrate the whole of its efforts upon furthering the orderly development of zoological nomenclature.

New University at Olomouc

THE difficulty of accommodating all students in the existing Czechoslovak universities has led to the opening of a new one at Olomouc in north Moravia. The ceremony took place on February 21 after a special train from Prague had brought President Beneš, members of the Czechoslovak cabinet, Sir Phillip Nichols (the British Ambassador) and other diplomatic personalities to Olomouc. The new university is named after Palacký, the Czechoslovak historian so long associated with both the Charles University and the National Museum of Prague; and in his speech Dr. Beneš referred to the fact that Prague's university had existed for almost six hundred years, and that the name of Palacký could appropriately be given to the new university in recognition of the historian's cultural work for the nation a hundred years ago. He said that the importance of education is fully realized in Czechoslovakia, where it is vital for a small nation to be in the forefront of progress. The immediate task is to overtake the years lost through the War and the German occupation.

The rector of the new university is Prof. J. L. Fischer, a comparatively young philosopher from the University of Brno, already well known on the Continent for his contributions to the modern philosophical approach to social problems. Perhaps better known in Britain is the dean, Dr. V. Lesný, previously professor of Oriental studies at Prague, who has travelled much in India and written several works on Indian culture, some of which have appeared in English. The best known of these is his study of Rabindranath Tagore. Olomouc is not a new centre of culture. It was the seat of an ancient Czechoslovak school in the sixteenth century. In the seventeenth century this became a catholic seminary, and its presses produced some early Slavonic books. The eighteenth century scientific journal, *Monatliche Auszüge*, edited by Joseph Petrasche, was published at Olomouc, then better known by its German name Olmütz.

Geology at University College, Swansea

It is announced that Dr. Duncan Leitch, at present lecturer in geology in the University of Glasgow, has been appointed to succeed Prof. T. Neville George as professor of geology at Swansea. Dr. Leitch was trained under the late Prof. J. W. Gregory, with whom he carried out researches on the metallic minerals of Kirkcudbrightshire and on some caves of Galloway. Most of his subsequent work has related to the palæontology and stratigraphy of the Carboniferous rocks, especially of Scotland, where in collaboration with Dr. John Weir he carried out an exhaustive study of the non-marine lamellibranchs of the Coal Measures and provided a sound basis for the correlation of the seams. In an important series of papers he has developed statistical methods, which are proving of wide application, for the study of fossils. There is great scope for statistical research in palæontology and in other branches of geology; and at Swansea, in close access to the areas where the standard sequence of Coal Measures zones was established, he will find good opportunities to extend these investigations.

Colonial University Grants Advisory Committee

The Secretary of State for the Colonies has, in accordance with a recommendation of the Commission on Higher Education in the Colonies, appointed a Colonial University Grants Advisory Committee to advise him on the expenditure of United Kingdom funds for the development of higher education in the Colonies. On the academic aspects the Committee will be guided by the opinion of the Inter-University Council for Higher Education in the Colonies. The secretary of the Inter-University Council, Mr. Walter Adams, has been appointed secretary of the new Committee also, and the following have been appointed members: Sir Hector Hetherington, vice-chancellor of the University of Glasgow (*chairman*); Miss Myra Curtis, principal of Newnham College, Cambridge; Lord Hailey; Sir James Irvine, vice-chancellor of the University of St. Andrews; Sir Walter Moberly, chairman of the University Grants Committee; Dr. Keith Murray, rector of Lincoln College, Oxford; Prof. D. Hughes Parry, vice-chancellor of the University of London; Dr. R. E. Priestly, vice-chancellor of the University of Birmingham; Mr. D. J. Sloss, vice-chancellor of the University of Hongkong; Mr. C. W. M. Cox, educational adviser to the Secretary of State for the Colonies; Mr. J. B. Williams, Finance Department, Colonial Office.

Experiments on Cosmic Rays in High-Flying Aircraft

A brief announcement has been issued by Dr. Gilbert Grosvenor and Dr. W. F. G. Swann in a News Bulletin of the National Geographic Society of Washington of some experiments on the origin of the meson component of the cosmic rays. The National Geographic Society, the Bartol Foundation and the U.S. Army co-operated in the experiments, which were made in a series of flights in a *B*29 aircraft at places, ranging from Northern Chile to Southern Canada, from the magnetic equator up to mag. lat. 48° N. and at altitudes up to 33,000 ft. The apparatus consisted of a number of coincidence counters arranged to record penetrating particles of which the direction of motion was in or near the vertical. The soft component (electrons and photons) was prevented from reaching the counters by a sufficient thickness of lead shielding. At 33,000 ft. the observed intensity of the mesons, using this particular experimental arrangement, was observed to increase by 33 per cent in going from mag. lat. 0° to mag. lat. 48°, and 50 per cent at 25,000 ft. The absolute change in intensity with latitude, in contrast with the above values of the relative changes, was greater at the higher altitude than at the lower.

The results show, in accordance with previous views, that a considerable fraction of the meson component is produced by primary charged particles, presumably protons, of such an energy that some of them are appreciably deflected by the magnetic field in approaching the earth. The decrease in the percentage variation of the intensity with latitude at increasing altitudes is attributed to the presence of a primary component which produces mesons in lead but is not sensitive to the magnetic field of the earth and is rapidly absorbed between 33,000 and 25,000 ft. This radiation could be made up of photons. The authors prefer, however, to attribute it to protons of great energy. In this case the observations suggest that the cross-section for the production of mesons by fast protons increases rapidly with increasing energy. In support of this view it is found that there is no increase in the meson intensity at 33,000 ft. at latitudes higher than 48° mag. N. A proton of such an energy that it could enter the earth's atmosphere at this latitude would not be stopped by the matter composing the atmosphere down to 33,000 ft. plus the lead of the apparatus if it loses energy only by the normal processes of ionization. The observed absorption must therefore be attributed to other processes which, the authors suggest, are connected with meson production.

Behaviour: An International Journal of Comparative Ethology

Interest in the study of animal behaviour (ethology) is growing rapidly. The results of comparative behaviour studies have in the past been scattered throughout a number of periodicals and other publications. The German *Zeitschrift für Tierpsychologie* was hitherto the only European journal devoted exclusively to the publication of modern behaviour studies; and during its short existence, it demonstrated clearly that a special journal of this kind fulfils a most important function in stimulating and promoting the study of the subject with which it deals; but its future is now in doubt. It has accordingly been decided to found a new international journal of comparative ethology to be called *Behaviour*.

The new journal will cover the scientific study of animal behaviour and will be open to reports of original research on animal behaviour and to theoretical papers calculated to promote the experimental study of the subject. Work on endocrinology and nerve physiology will be given its due share of space, so long as it is clearly related to and designed to illuminate the behaviour of the animal. The editors are Prof. H. Hediger (Basel); Prof. P. Palmgren (Helsingfors); Dr. W. H. Thorpe (Cambridge); and Dr. N. Tinbergen (Leyden). *Behaviour* will appear at first at irregular intervals in issues of about 160 pages, the frequency depending on the amount of material offered for publication and on the availability of suitable paper, etc. The price of a volume of about 320 pages will be about 20 Dutch guilders. It is being published by E. J. Brill of Leyden.

Cambridge Summer School in Metal Physics

A SUMMER SCHOOL in Metal Physics will be held during September 1–12 inclusive in the Cavendish Laboratory, Cambridge. The School will provide an introduction to the application of physical methods to the examination and utilization of metals, and is intended for those whose researches require a more fundamentally physical approach than is usual in ordinary metallurgical and engineering practice. The lectures and demonstrations will deal with (*a*) application of X-ray methods in the examination of metals, (*b*) physical and mechanical properties of metals. Both parts will be taken by all attending the School, and for part (*a*) an elementary knowledge of X-ray diffraction methods and of crystal symmetry will be assumed; during the School it will be possible to provide only a very brief review of these aspects of the subject-matter. A detailed syllabus and form of application for admission can be obtained from G. F. Hickson, secretary of the Board of Extra-mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than June 7.

University of Glasgow

THE bicentenary of the institution of a lectureship in chemistry in the University of Glasgow falls during the present session. Dr. William Cullen was appointed in 1747 and held the lectureship for nine years, being succeeded by Dr. Joseph Black in 1756. To celebrate the bicentenary, four lectures will be given in the Department of Chemistry, on May 9, 16, 23 and 30, by Dr. Douglas Guthrie, on "William Cullen and His Times"; Prof. John Read, on "Joseph Black, the Teacher and the Man"; Dr. Alexander Fleck, on "Scottish Industrial Development of the Cullen/Black Period"; Prof. A. R. Todd, on "Glasgow Chemistry in the Twentieth Century".

Society for Experimental Biology: Utrecht Meeting

THE Society for Experimental Biology is holding a meeting at Utrecht during April 11–14; this is the first foreign meeting which the Society has held. An invitation to hold the meeting in Utrecht was given by the botanists and zoologists of the University of Utrecht, on the initiative of Prof. G. J. van Oordt, who had been a visitor at the Society's meeting last year at Newcastle. Papers will be presented by both British and Dutch workers in the field of experimental biology. A party of about seventy British scientific workers will be visiting Utrecht for the meeting. Many topics will come under discussion, including some aspects of entomology and parasitology, histogenesis, electro-physiology, respiration of both animals and plants, permeability phenomena and plant hormones. On Sunday, April 13, there will be no formal sessions, but two expeditions, one to the reclaimed areas of the Zuider Zee, and the other to the bulb fields; on this evening, all those attending the conference will dine together at Amsterdam.

Servo-Mechanisms

A RAPIDLY growing literature gives some indication of the extent to which war-time developments of automatic control systems or servo-mechanisms are finding application in industry. These applications range from relatively simple remote-position control systems to the overall control of complete industrial processes. A specialized theoretical technique has been evolved for the design of such systems and the analysis of their behaviour. A number of papers on the various aspects of this subject will be presented at a Convention on Automatic Regulators and Servo-mechanisms to be held at the Institution of Electrical Engineers during May 19–23.

Announcements

DR. E. D. MERRILL, Arnold professor of botany at Harvard University, has been made an honorary staff member of the Botanic Gardens, Buitenzorg, Java. A diploma was handed to him by Dr. C. G. G. J. van Steenis, senior botanist of the Gardens, at a dinner for the editorial board of *Chronica Botanica* during the recent Boston meetings of the American Association.

THE Herbert Jackson Prize for 1946 of the London, Midland and Scottish Railway has been awarded to Mr. J. O. Cowburn, formerly engineering research assistant, Derby, for a paper entitled "The Development of a Successful Leakage-Testing Instrument for use on Vehicles fitted with the Automatic Vacuum Brake".

MR. WILLIAM WILLIAMSON, joint author of the Ray Society volumes "The British Hydracarina", vols. 1–3 (1925–29), has presented to the library of the Royal Society of Edinburgh more than a thousand papers and a number of volumes dealing with the Hydracarina. Specimens have been lodged with the Royal Scottish Museum, Edinburgh, the Department of Zoology of the University of Edinburgh, and the British Museum (Natural History), London.

THE X-Ray Analysis Group of the Institute of Physics has recently established an X-Ray Tube Panel, under the chairmanship of Dr. A. Taylor. The Panel will review existing and projected X-ray tubes and X-ray tube production in Great Britain. A questionnaire is being sent to all members of the X-Ray Analysis Group of the Institute and to certain others known to be interested in crystallographic X-ray tubes. Communications should be sent to the honorary secretary of the Panel, Mr. J. N. Kellar, Crystallographic Laboratory, Cavendish Laboratory, Cambridge.

ERRATUM.—In "Role of Sulphydryl Groups in the Action of Acetylcholine and Inhibition of the Vagus Nerve" by Prof. Ch. S. Koschtojanz and T. M. Turpajew published in *Nature* of December 7, 1946, p. 837, paragraph 5, last line, for "cystein" read "cystine".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Determination of the Energy and Momentum of Fast Neutrons in Cosmic Rays

Previous experimenters, working on the multiple disintegration phenomena produced by cosmic radiations, have concluded that some at least of the nuclear explosions are produced by fast neutrons. In approaching the problem of determining the energy of such neutrons, we meet the difficulty that the usual method, in which observations are made on the recoil protons which the neutrons produce by collision with hydrogen nuclei, is not applicable. It is therefore important to develop alternative methods, and, for this purpose, we have examined the possibility of employing the nuclear reaction between boron and fast neutrons.

We first exposed boron-loaded plates to the homogeneous groups of neutrons produced by the bombardment of boron by 900 keV. deuterons from the Cambridge high-tension generator. Provision was made for determining the direction of the neutron flux at any point in the plate with an accuracy of ± 1°, and the plates were placed in such a position that they were exposed to neutrons emitted in the direction of motion of the primary deuterons. In these conditions the mean energies of the fastest two groups of neutrons passing through the plates were 9·6 MeV. and 13·4 MeV. respectively.

A microscopic examination of the exposed plates after development shows, in addition to numerous short tracks due to the reaction

$$\mathrm{B}^{10}_{5} + n^{1}_{0} \rightarrow \mathrm{Li}^{7}_{3} + \mathrm{He}^{4}_{2}, \qquad (1)$$

many three-particle disintegrations. A photomicrograph of one of these events is reproduced in Fig. 1 (*a*). The discriminating power of the emulsion is sufficiently great to allow us to identify the tracks of two α-particles, α_1 and α_2, and a less heavily ionizing particle τ_1, composing the 'star'. We conclude that the disintegration is produced in the well-known reaction[1]

$$\mathrm{B}^{10}_{5} + n^{1}_{0} \rightarrow \mathrm{He}^{4}_{2} + \mathrm{He}^{4}_{2} + \mathrm{H}^{3}_{1}, \qquad (2)$$

of which the Q value, as determined from the masses of the nuclei, is + 0·4 MeV.

From the observed lengths of the tracks and the range-energy relation for tritons and α-particles in the emulsion[2], we can determine the energy of each of the particles. The values so obtained are: particle α_1, 7·4 ± 0·2 MeV.; particle α_2, 1·4 ± 0·4 MeV.; and triton (τ_1), 5·0 ± 0·1 MeV. The total energy is thus 13·8 ± 0·5 MeV., and this corresponds to an energy of the incident neutron of 13·4 ± 0·5 MeV. We can also compare the vector sum of the momenta of the three particles with that of the incident neutron, assuming the latter to have an energy equal to the mean energy of the fastest group of neutrons from the source. We chose the momentum of a proton of energy 0·5 MeV. as a convenient unit. The tracks of the three charged particles are nearly co-planar, and in Fig. 2 (*a*) we represent their momenta in a vector diagram. The resultant momentum is represented in magnitude and direction by the line *OP*, and this is nearly coincident with *OR*, the momentum of the incident neutron—the two magnitudes being 5·6 ± 0·6 units and 5·2 units respectively, and the difference in direction less than 2°. The errors in the determination of the total energy and momentum are mainly due to the uncertainty in the energy of the short-range α-particle, and they would be less if the ranges of the particles were more nearly equal.

In view of the satisfactory results obtained in work with neutrons of known energy and momentum, we next examined boron-loaded plates exposed to the cosmic rays, at the Pic du Midi, at a height of 2,800 m. We found a number of disintegration stars, very similar in form to those produced by the 13·4 MeV. neutrons; an example is reproduced in the mosaic of photomicrographs in Fig. 1 (*b*). From the grain-spacing in the tracks we can identify α_3 and α_4 as α-particles and τ_2 as a particle of charge $+e$. All the tracks end in the emulsion, so that their ranges can be determined; but, owing to the lack of an established range-energy relation extending up to 50 MeV., we can only deduce an approximate value of the energy of the particle α_3. By extrapolating the range-energy curve obtained in previous experiments, we obtain a value of 26·5 ± 1·5 MeV. The energy of particle α_4 is 2·9 ± 0·2 MeV. and, if τ_2 is a triton, its energy is 7·4 ± 0·1 MeV.

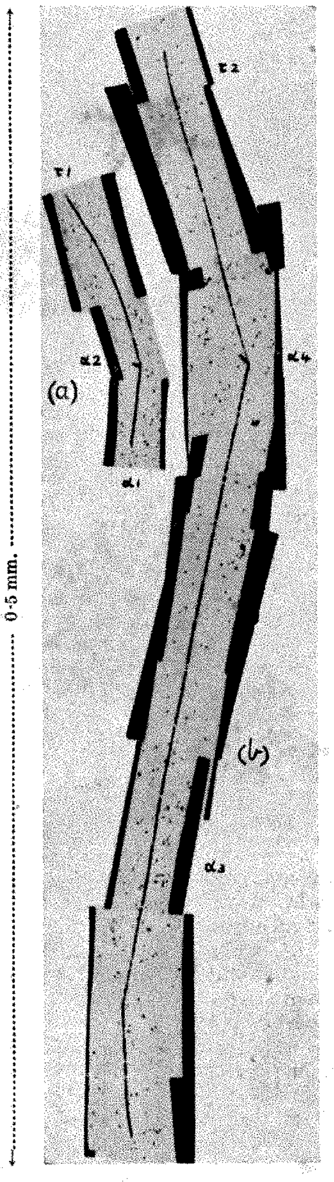

Fig. 1. THE BLACK EDGES OF THE INDIVIDUAL PHOTOGRAPHS HAVE BEEN RETAINED TO SHOW THE METHOD OF MAKING THE MOSAIC. THE PHOTOGRAPHS HAVE NOT BEEN 'RETOUCHED' AT ANY STAGE IN THE PHOTOGRAPHIC PROCESS

If we construct a momentum diagram, Fig. 2 (*b*), we find a value for the momentum of the incident particle of 9·5 ± 0·9 units. Assuming the particle to be a neutron, its calculated energy is 45 ± 8·5 MeV. as compared with the value, obtained from the total kinetic energy of the three particles, of 36·8 ± 1·8 MeV. If, alternatively, we calculate the mass of the incident particle from the observed energy and momentum, we obtain the value 1·23 ± 0·30 mass units.

In view of the uncertainty in the energy of particle α_3, and of the direction of particle α_4, the above result is

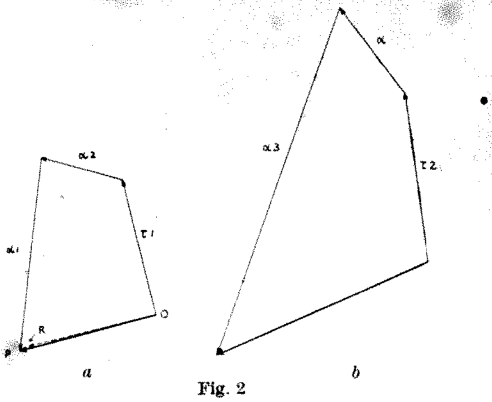

Fig. 2

very satisfactory and makes it certain that the disintegration was produced by a fast neutron and not by the photo-disintegration of a boron nucleus. We conclude that determinations of the energy and momentum of fast neutrons can be made with boron-loaded plates. Owing to the short range of tritons and α-particles, as compared with protons of the same energy, and the division of the energy among three particles, it may be possible, with thick emulsions, to apply the method in experiments with neutrons of energy up to 100 MeV. and possibly higher.

It must be anticipated that, as the energy of the intermediate nucleus increases, there will be a growing tendency for the proton and two neutrons, which at lower energies appear together as a triton, to be emitted as separate particles. It can be shown, however, that in very few cases will there be consistency between the observed energy and momentum if a star, produced in fact from a reaction involving neutron emission, is interpreted as due to reaction (2). In such cases, if we make reasonable assumptions about the distribution of the emitted neutrons, we can show that the probability that the calculated mass of the incident particle will depart from unity by amounts less than the 'probable error' is small. In the particular case of the star shown in Fig. 2 (*b*), it is 8 per cent. Further, in ambiguous cases, it may be possible, with improvements in the discriminating power of the emulsions, to distinguish the tracks of tritons from those of protons and deuterons. Although it is possible to get better discrimination between the various types of fast particles by using the *C*1, *E*1 and *D*1 series of emulsions, we have found that they cannot be employed for work in cosmic rays where long exposures are necessary because of the rapid fading of the tracks[2]. In the present experiments we employed *C*2 and *B*1 emulsions, in which the fading after a month is not so serious. We may emphasize that the other light elements may also be employed for this type of work. Beryllium and lithium are of particular interest because the modes of disintegration are simple.

The present results illustrate an important general feature of the photographic method. Because it is possible to determine the energy and the momentum of all the charged particles, arising from the disintegration of a nucleus in the emulsion, the method is particularly suitable for the study of individual disintegrations, especially those in which more than two particles are emitted.

The investigation of the various modes of disintegration of boron under fast neutron bombardment, including an examination of the angular distribution of the disintegration particles, is continuing, and a complete account of the experiments will be published elsewhere.

We have pleasure in thanking Dr. W. E. Burcham and Mr. D. L. Livesey for their kindness in making it possible for us to obtain exposures to fast neutrons from the Cavendish high-tension generator. We are greatly indebted to Prof. J. Baillaud, director of the Observatory of the Pic du Midi, to Dr. Hugon and to Prof. Max Cosyns for assistance in obtaining the exposures to the cosmic rays. We wish to express our gratitude to Dr. C. F. Powell for many discussions, and for generous assistance.

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Jan. 16.

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[1] Chadwick and Goldhaber, *Nature*, **135**, 65 (1935); *Proc. Camb. Phil. Soc.*, **31**, 612 (1935). Taylor, *Proc. Phys. Soc.*, **47**, 873 (1935).

[2] Lattes, Fowler and Cuer, *Proc. Phys. Soc.*, in the press.

Emission of Light Charged Particles in the Fission of Uranium

AT the Physical Society's Conference on Fundamental Particles, held at Cambridge in July 1946, we reported that a light charged particle is occasionally emitted in the fission of uranium by slow neutrons, in addition to the two heavy fragments. This was observed during an examination of fission fragment tracks produced in Ilford photographic emulsions by a method which we have previously described[1]. Similar observations have recently been reported by Tsien, Chastel, Ho and Vigneron[2].

In a detailed investigation of this phenomenon, we have examined 25,000 fission tracks using emulsions which were sensitive to α-particles and heavier

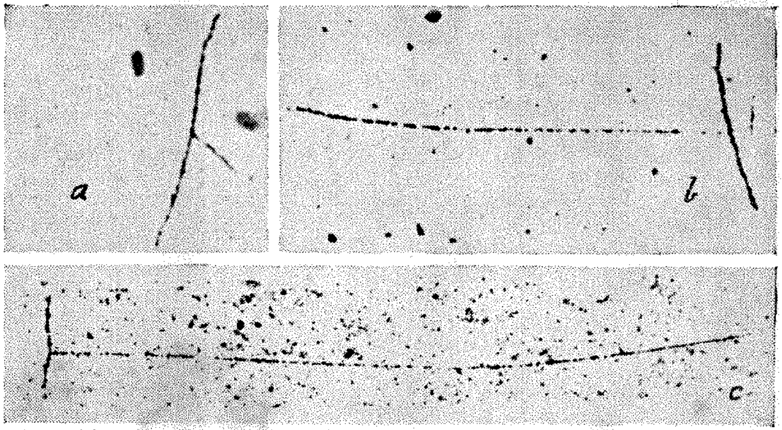


Fig. 1. (*a*) LIGHT-PARTICLE RANGE = 5·5 μ (0·87 CM. AIR EQUIVALENT). (*b*) LIGHT-PARTICLE RANGE = 53 μ (9·5 CM. AIR EQUIVALENT). (*c*) LIGHT-PARTICLE RANGE = 132μ (24 CM. AIR EQUIVALENT).

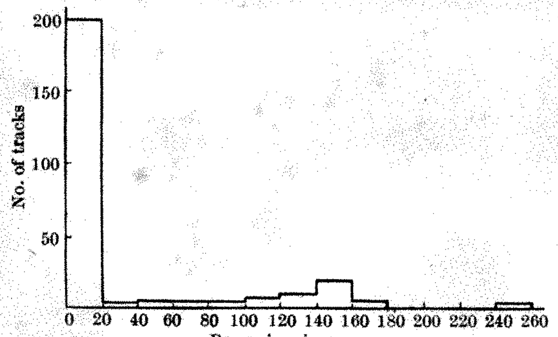


Fig. 2

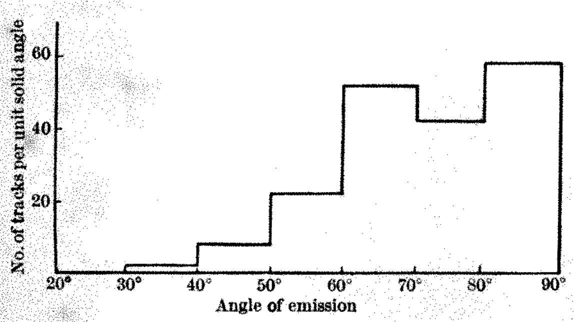


Fig. 3

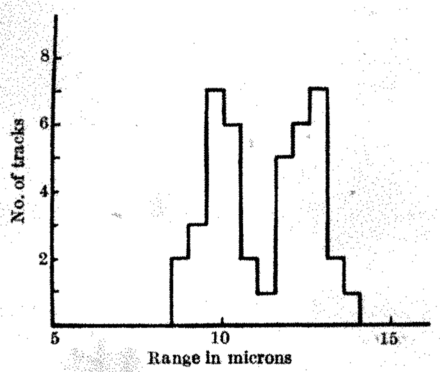


Fig. 4

ions but insensitive to protons. In cases where the emission of a third light particle was observed, measurements of the range of the particle and of the angle between its track and those of the heavy fragments were carried out. Typical examples of the tracks are shown in the photomicrographs, Fig. 1 *a*, *b*, *c*. The grain density in the light-particle tracks is consistent with the hypothesis that these particles are α-particles, although the possibility that they are nuclei of slightly greater mass cannot be excluded. It is, however, certain that the particles are not recoil nuclei projected by fission fragments in their passage through the emulsion, since the observed directions of emission are inconsistent with the momentum relations for such collision processes.

The range distribution of the light particles observed is shown in histogram form in Fig. 2; it shows that particles of all ranges from the lower limit of detection of 1·7 microns (2·8 mm. air equivalent) to a maximum in excess of 250 microns (45 cm. air equivalent) are present. A considerable number of particles fall into a short-range group; these particles had been detected previously in this Laboratory by coincidence counting methods[3]. The abundance of light particles of all ranges is 1 in 80 ± 4 fission events; for particles of range greater than 5 microns (equivalent to 8 mm. of air) it is 1 in 340 ± 30 fission events.

The angular distribution of the light-particle tracks has been determined, and is shown in Fig. 3, in which the number of tracks per unit solid angle is plotted against the angle between the direction of emission of the light particle and the fission fragment tracks. No significant difference between the angular distribution of the short-range and long-range particles has been detected. It is evident from Fig. 3 that the particles are emitted preferentially in directions nearly perpendicular to the fission fragment tracks.

Assuming that the third particle is emitted simultaneously with the two heavy fragments, its track defines the point of fission, and so the range distribution of the individual fission fragments in these events may be determined. The results of such range measurements give a distribution shown in Fig. 4, which refers to those events characterized by the emission of a long-range particle. The double peak of the distribution indicates that there is unequal division of mass in the modes of fission which produce light charged particles of high energy.

In the 25,000 fission events investigated, we have found no evidence of fission of the uranium nucleus into more than three charged particles.

We should like to thank Prof. N. Feather for much helpful advice. A more detailed account of the work will be published elsewhere.

L. L. Green
D. L. Livesey

Cavendish Laboratory,
Cambridge.

[1] Green and Livesey, *Nature*, **158**, 272 (1946).

[2] Tsien, Chastel, Ho and Vigneron, *C.R. Acad. Sci. Paris*, **223**, 986 (1946).

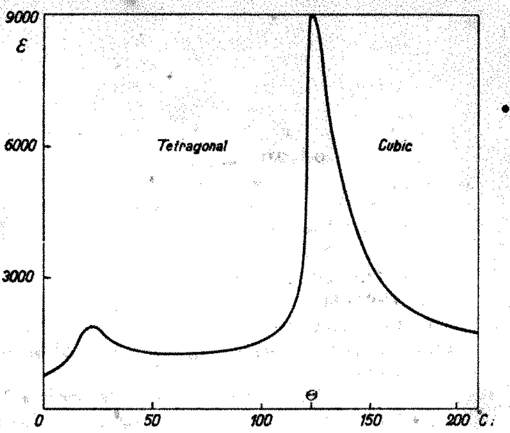
[3] Cassels, Dainty, Feather and Green, unpublished.

Effect of Temperature on the Permittivity of Barium Titanate

It is well known[1] that the dielectric behaviour of barium titanate and some mixed crystals of it with related compounds is quite different from most other materials (see accompanying illustration). At a certain temperature, θ, a very high value of the permittivity ε is found. On the left side of the peak, ε decreases with decreasing temperature though still some secondary maxima are found; on the high-temperature side of the peak, however, ε decreases monotonically.

According to Rooksby[2] and Miss Megaw[3], barium titanate shows an ideal cubic perovskite structure at temperatures above θ. In the neighbourhood of θ, a tetragonal distortion of the lattice takes place, persisting down to liquid–air temperatures.

In order to explain the permittivity–temperature curves in the cubic region, it has been assumed[4] that in these lattices permanent dipoles occur. At first sight this may seem reasonable, because for barium and lead titanates the ratio of the ionic distances is such as to allow a rather large space for the titanium ion. From electrostatic considerations it might be expected that the potential curve of the titanium ion would not show one minimum situated in the



DIELECTRIC CONSTANT OF BARIUM TITANATE AS A FUNCTION OF TEMPERATURE MEASURED WITH A.C. VOLTAGE OF 100 V./CM. AND A FREQUENCY OF 5 KC./S.

centre of the TiO_6 octahedron but several excentric positions of minimal energy.

By plotting $\frac{\varepsilon - 1}{\varepsilon + 2}$ against temperature in the cubic region, Rushman[4] derived a dipole moment of about $0{\cdot}1 \times 10^{-18}$ E.S.U., which seemed to be a plausible value in comparison with the magnitude of the dipole which is estimated from the free space available for the titanium ion.

In these calculations, however, the effect of thermal expansion has been neglected. This effect will cause a decrease of permittivity with increasing temperature.

We have tried to describe the dielectric properties by means of the Clausius–Mosotti formula :

$$\frac{\varepsilon - 1}{\varepsilon + 2} = \frac{4\pi}{3} n\alpha, \qquad (1)$$

where n is number of unit cells per cm.^{3} ; α is polarizability per unit cell (in the general case α may contain a dipole contribution).

From (1) the following expression for the temperature coefficient (T.C.) can be derived :

$$\text{T.C.} \equiv \frac{1}{\varepsilon}\frac{d\varepsilon}{dT} = \frac{(\varepsilon - 1)(\varepsilon + 2)}{\varepsilon}\left\{-\beta + \frac{1}{3}\frac{1}{\alpha}\frac{d\alpha}{dT}\right\}, \quad (2)$$

where β is coefficient of linear expansion.

For TiO_2 (rutile) we found at room temperature experimentally a temperature coefficient of $-8{\cdot}3 \times 10^{-4}$, whereas the term $-\beta\,\frac{(\varepsilon - 1)(\varepsilon + 2)}{\varepsilon}$ calculated from β- and ε-measurements was found to be also $-8{\cdot}3 \times 10^{-4}$. From this we may conclude that here the temperature-dependency of α may be neglected.

In the case of high values of ε, (2) may be approximated by

$$\frac{1}{\varepsilon}\frac{d\varepsilon}{dT} = -\beta\varepsilon. \qquad (3)$$

From this it follows that

$$\frac{1}{\varepsilon} = \beta(T - C), \qquad (4)$$

which is exactly the hyperbolic law found by Rushman[4] in the cubic region of barium titanate (C is a temperature only slightly different from θ).

When the temperature curve for rutile and for some titanates in the cubic region is derived by means of formula (4), we find that the experimental data can be represented in a quite accurate way by formulæ of this type.

$$\begin{array}{ll}
TiO_2 & \frac{1}{\varepsilon} = \left\{0{\cdot}73 \times 10^{-5}\,(T + 907)\right\} \\
BaTiO_3 & \frac{1}{\varepsilon} = \left\{0{\cdot}98 \times 10^{-5}\,(T - 393)\right\} \\
(Ba\ 0{\cdot}70,\ Sr\ 0{\cdot}30)\ TiO_3 & \frac{1}{\varepsilon} = \left\{1{\cdot}07 \times 10^{-5}\,(T - 306)\right\} \\
(Ba\ 0{\cdot}40,\ Sr\ 0{\cdot}60)\ TiO_3 & \frac{1}{\varepsilon} = \left\{0{\cdot}90 \times 10^{-5}\,(T - 188)\right\} \\
Sr\ TiO_3 & \frac{1}{\varepsilon} = \left\{0{\cdot}96^5 \times 10^{-5}\,(T + 65)\right\}
\end{array}$$

For β we found by expansion measurements

TiO_2	$0{\cdot}73 \times 10^{-5}$
$BaTiO_3$	$0{\cdot}95 \times 10^{-5}$
$(Ba\ 0{\cdot}65,\ Sr\ 0{\cdot}35)\ TiO_3$	$0{\cdot}98^5 \times 10^{-5}$

From this we may conclude that the α of these titanates is constant for temperatures above θ. The temperature coefficient appears to be a consequence of the variation of density only.

Hence we believe that in the temperature region of cubic structures there is no permanent dipole moment ; whereas in the tetragonal region where 'ferro-electric' phenomena (dependence on field strength, hysteresis) are observed, the assumption of such dipoles seems to be quite plausible.

A fuller account of these considerations will be published shortly.

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Jan. 6.

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[1] Wul, B., *Nature*, **156**, 480 (1945).

[2] Rooksby, H. P., *Nature*, **155**, 484 (1945).

[3] Megaw, H. D., *Nature*, **155**, 484 (1945) ; **157**, 20 (1946) ; *Proc. Phys. Soc.*, **58**, 133 (1946).

[4] Rushman, D. F., Faraday Society meeting on dielectrics (1946).

Electrical Conductivity in Insulating Amorphous Solids

WE have carried out some preliminary experiments to find the current-voltage stress characteristics of soda-lime glass, this being taken as an example of an amorphous solid having the properties of an electrical insulator.

The conductivity stress relationships have been predicted theoretically by Dr. Fröhlich[1], and our conclusions would seem to be in agreement with his theory. Some previous workers[2] in the field of dielectric conductivity have restricted themselves to D.C. measurements of the conductivity, and their results have often indicated changes of conductivity with time (often over a period of minutes or hours). Other workers[3] have investigated the so-called 'breakdown voltage stress' and analysed their results statistically, thus producing valuable practical information.

We felt that there was considerable uncertainty in the definition of 'breakdown-stress', particularly as many workers insist on applying their stress for a definite time before 'breakdown' occurs. Believing that this breakdown may be either purely of an electrical nature, or purely of a mechanical nature due to change of state arising from thermal heating effects, we are investigating the conductivity of insulators at voltage stresses up to the 'breakdown' stress. It is thought that this will yield information

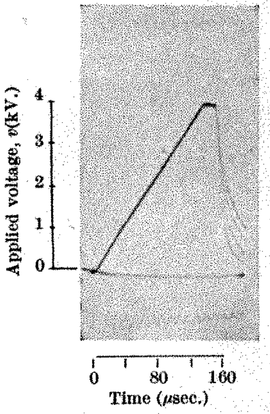

Fig. 1 *a*. APPLIED VOLTAGE WAVE-FORMS

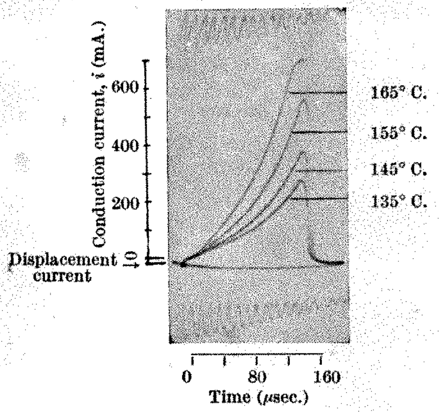

Fig. 1 *b*. CURRENT WAVE-FORMS

on the actual behaviour of conductivity before 'breakdown'.

In brief, our method was as follows. A small thin glass bulb blown at the end of a tube was filled with, and inserted in, mercury, thus providing two mercury electrodes. A single pulse the magnitude of which increased linearly with time for approximately 150 μsec. from zero up to 4 kV. max. was applied between the electrodes, and the sum of the displacement and conduction currents through the thin insulating bulb recorded at different temperatures by means of a recording cathode-ray oscillograph (see Figs. 1*a* and *b*). It will be seen that the conductivity increased with temperature, as was to be expected from the well-known law

$$\sigma = \sigma_0 \exp\left(-W/kT\right) \qquad (1)$$

applicable to low field strengths. The conductivity, however, also increases with applied field strength, the theoretical law[1] being

$$\log_e \frac{\sigma}{\sigma_0} = \frac{V_1}{\Delta V} \cdot \frac{1}{e} \cdot \frac{F^2}{F^{*2}} \qquad (F \ll F^*), \qquad (2)$$

where F^* is critical field strength, F is applied field strength, σ is conductivity, V_1, ΔV, σ_0 are constants, e is 2·73. Our practical arrangement did not allow us to determine σ or F absolutely, but gave figures proportional to each.

If the theoretical law (Equation 2) is true, then we expect to find

$$\log \frac{i}{v} = K_1 + K_2 v^2, \qquad (3)$$

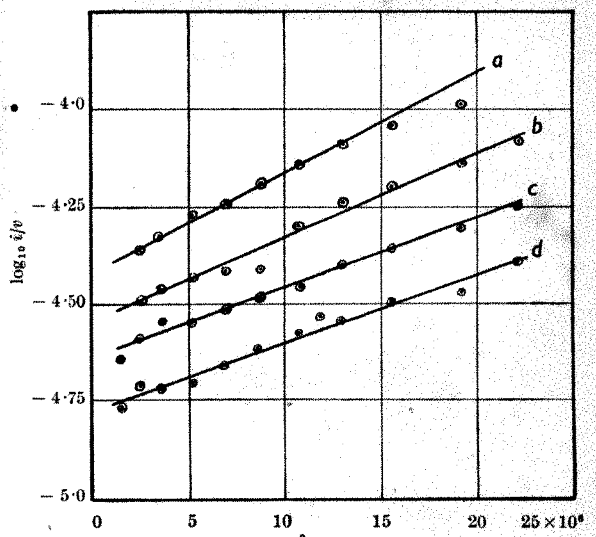

Fig. 2. (*a*) 165° C.; (*b*) 155° C.; (*c*) 145° C.; (*d*) 135° C.

where i is instantaneous current, v is instantaneous applied voltage, K_1, K_2 are constants.

$\text{Log}_{10}\, i/v$ is plotted against v^2 in Fig. 2, and a straight line results, apparently verifying the square law relationship in F of Equation 2.

It is believed that this method of approach to the problem of electrical conductivity in solids is new, and that it has a great advantage over previous methods of measuring conductivity at large field strengths, as it almost entirely eliminates complications due to heat generated in the specimen by the conduction current.

We are indebted to Dr. H. Fröhlich of the University of Bristol for a helpful discussion, and to Dr. D. M. Robinson for suggesting the investigation and the experimental method.

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Department of Electrical Engineering,
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Jan. 11.

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[1] Fröhlich, H., E.R.A. Report L/T.153 (1945).

[2] Hubmann, *Ann. Phys.*, **9**, 733 (1931).

[3] Austin and Pelzer, E.R.A. Report, L/T.138 (1943).

Detectability of the Negative Proton

IT is customary to employ Dirac's equation to describe the proton, which is known to have spin ½. Therefore, it is to be expected that the negative proton should exist, though this particle has never been detected experimentally. In a study of the production and annihilation of negative protons[1], it was shown that it is not surprising that the particle has not been observed; but it was suggested that it could be observed, if certain cosmic ray experiments were improved. The calculations were based on the resolution of the field of a fast nucleon into a spectrum of mesons by the method of v. Weizsäcker[2] and E. J. Williams[3], and for simplicity account was taken only of the pseudoscalar mesons.

The problem has again been studied[4], account being taken not only of the pseudoscalar mesons of the Weizsäcker spectrum but also of its longitudinal and transverse mesons, in accordance with the Møller–Rosenfeld form of the meson theory[5]. It is found that the rate of production of negative protons should be three or four times smaller than that given in the earlier paper. However, it must be noted that all the numerical results are probably upper limits and should perhaps be two to five times smaller. In fact, the densities of the mesons in the Weizsäcker spectrum depend rather sensitively on the value of the lower limit of the impact parameter, which has been taken to be the Compton wave-length of the nucleon $\hbar/Mc$, but which in reality may be somewhat larger[4].

When the negative proton has been produced by the collision of a cosmic ray meson and a nucleon, it may escape detection by producing mesons and so losing its negative electrical charge. It appears from cosmic ray experiments that the cross-section φ for meson production by a proton, or negative proton, is at least $4\cdot6 \times 10^{-26}$ cm.², that is $(\hbar/\mu c)^2$, where μ is the mass of the meson[7]. The corresponding mean free path in nuclear matter is

$$\tau = 1/N\varphi,$$

where N is the number of nucleons the total volume of which is equal to 1 cm.³. Taking the radius of the lead nucleus to be $1\cdot1 \times 10^{-12}$ cm., one obtains

$$N = \frac{3 \times 207 \times 10^{36}}{4\pi \times 1\cdot1^3}, \text{ so that } \tau = 6 \times 10^{-13} \text{ cm.}$$

Hence the maximum value of the mean free path of the negative proton in nuclear matter is about four times the average distance between the nucleons in a nucleus.

Assuming that the mean free path is approximately equal to the average distance between two nuclear particles, one may estimate what is the probability that a negative proton will escape from the nucleus where it has been formed without losing its negative charge. It will lose its charge if it collides with a nucleon, and that will certainly happen unless it has been produced in the surface layer. However, even in the case of a large nucleus such as lead, most of the nucleons are in this layer. If the negative proton has been produced on the surface, then there is roughly a 50 per cent chance that it will not collide with a nucleon. Thus the process of meson production in the nucleus will scarcely reduce the probability of detecting the negative proton by more than a factor 3.

When a negative proton has emerged from the nucleus, it may be lost to observation by producing mesons in the surrounding material. Its mean free path is less than 4 cm. of lead, which corresponds approximately to one thirtieth of the atmosphere. So a negative proton formed by the collision of a cosmic ray meson and a nucleon in the atmosphere will not come down to sea-level unless it has been produced in the lowest one thirtieth of the atmosphere. This considerably reduces the chance of observing the negative proton in sea-level cosmic radiation[6]; hence with the present experimental technique it is very unlikely that the particle could be detected by examining the charge of the particles which cause the heavy tracks in cloud-chamber photographs.

If one studies the production of negative protons by the passage of mesons with energy greater than 4×10^9 eV. through a lead plate of 1 cm. thickness and allows for the loss by meson production, one finds that at least one hundred thousand mesons would have to penetrate before one negative proton would be formed. Thus a long series of experiments would now be required to observe the particle; though, when the present experimental methods have been improved, it may not be too difficult to detect the negative proton.

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[1] McConnell, J., *Proc. Roy. Irish Acad.*, A, **50**, 189 (1945); cf. *Nature*, **158**, 280 (1946).

[2] *Z. Phys.*, **88**, 612 (1934).

[3] *Kgl. Dansk. Vid. Selsk.*, **13**, 4 (1935).

[4] McConnell, J., *Proc. Roy. Irish Acad.*, in the press.

[5] *Kgl. Dansk. Vid. Selsk.*, **17**, 8 (1940).

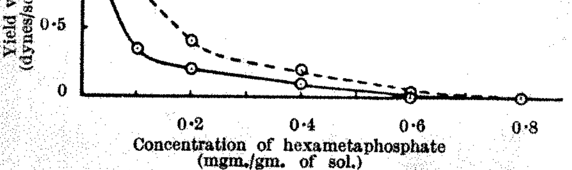
[6] Cf. Heitler, W., and Peng, H. W., *Proc. Roy. Irish Acad.*, A, **49**, 109 (1943).

[7] Cf. Heitler, W., and Walsh, P., *Rev. Mod. Phys.*, **17**, 252 (1945).

Effect of Sodium Hexametaphosphate on the Yield Value and Viscosity of a Hydrogen Bentonite Suspension

Phosphates, especially the sodium hexametaphosphate, are now widely applied for the treatment of drilling muds used in the rotary drilling of oil-wells[1]. Some papers dealing from the colloid chemical point of view with the action of phosphates on clay suspensions have recently been published[2]. A majority of investigators appears to have expressed the results of their measurements in terms of apparent viscosity and to have paid insufficient attention to the progress of the reaction. We have tried in our work to overcome these objections, and have obtained some results which seem to need further explanation. Results of detailed investigations will be published elsewhere; but the preliminary observations appear to be sufficiently interesting to be communicated here.

We have used a rotary viscometer designed by Mukherjee and Sen Gupta[3]. Various quantities of a sodium hexametaphosphate solution were added to a 12 per cent aged hydrogen bentonite suspension, prepared by electrodialysis, and the requisite quantities of water were added to make the suspensions 10 per cent in every case. Viscometric measurements were made using the suspensions just after addition of the phosphate, and then at intervals up to a period of twenty days. 'Initial' and 'final' yield values and viscosities (obtained from graphical extrapolation) are shown in the accompanying figure.



Full curve, immediate (initial); broken curve, after 20 days (final)

It appears from the graph that the phosphate has a greater effect in reducing the yield value than the viscosity. The more important observation which was not quite expected is that, while the viscosity increases on standing, tending to reach the original figure, the yield value for the higher concentrations of phosphate (0·6–0·8 per cent) does not increase on standing up to a period of twenty days. The results cannot be explained by assuming that the phosphate ion is fixed by aluminium or enters the clay complex; for while this would account for the reversion of viscosity to the original figure, the constancy of the yield value seems to be at variance with this hypothesis.

We acknowledge our indebtedness to Mr. K. D. Bhabock for his collaboration in the experimental work.

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[1] Evans, P., and Reid, A., *Trans. Min. Geol. Inst. India*, 32, 3 (Dec. 1936).

[2] Loomis, A. G., Ford, T. F., and Fidlam, J. F., *Petroleum Tech.*, T.P., 120 (May 1940). Garrison, A. D., and ten Brink, K. C., *Petroleum Tech.*, T.P., 1124 (Nov. 1939).

[3] Mukherjee, J. N., and Sen Gupta, N. C., *Indian J. Phys.*, 16, 66 (1942).

Theory of Molecular Coupling in Polar Liquids

In 1939 I published[1] a general outline of the theory of the phenomena of molecular orientation in polar liquids. During the War I have generalized and worked out this theory in more detail.

Four effects of molecular orientation have been considered: (i) dielectric polarization, (ii) dielectric saturation in a strong electric field[2], (iii) electric birefringence (Kerr effect), and (iv) magnetic birefringence (Cotton – Mouton effect). The only liquid in which all these effects have been thoroughly examined is nitrobenzene. Fig. 1 represents the experimental results for nitrobenzene and its solutions in non-polar solvent (benzene). R, R_S, R_K and R_{CM} are 'reducing factors' corresponding to these effects respectively. Reducing factors are defined as the ratio of a 'molar constant', for example, molar polarization $P^{\text{dip}} = \dfrac{4\pi N \mu^2}{9\,kT}$, calculated for a liquid or its solution, to the same 'molar constant' (for example, $P^{\text{dip}}_{\text{gas}}$), determined for the same substance in the gaseous state. The calculation is based on the assumption of the validity of the Lorentz formula for the local field.

I have also applied the Onsager field[3] to the calculation of molar constants for these four effects from experimental data. The corresponding reducing factors are plotted in Fig. 2 against the number of dipole molecules per cm.^{3} of solution, as before. The curves show a quite different type of variation from that of the Lorentz field. First, the 'molar constants' are not constant, in disagreement with what might be expected on the basis of Onsager's theory. Further, the increase of R and R_K observed for higher concentrations indicates that a new kind of molecular coupling (kind III) must be considered to explain this behaviour.

In the paper quoted above[1], I assumed two kinds of coupling forces. The coupling of kind I is that of Fowler – Debye[4,5] due to the combined action of a great number of surrounding molecules. The coupling of kind II consists in the transitory formation of unstable and non-rigid pairs with the nearest neighbouring molecule. The theory based on these assumptions gives only a qualitative agreement with the Lorentz curves represented in Fig. 1. It explains in particular the change of sign of R_S and the fact that R_{CM} is greater than unity[6]. It is impossible, however, to obtain a quantitative agreement between the theory and the full set of Lorentz curves given in Fig. 1.

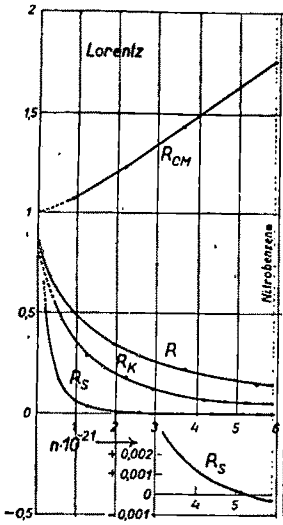

Fig. 1

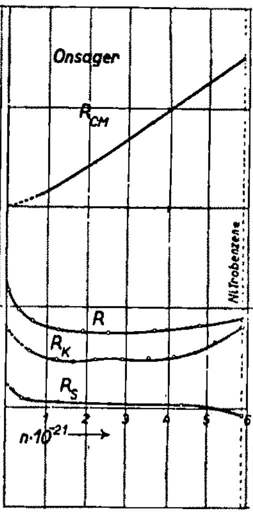

Fig. 2

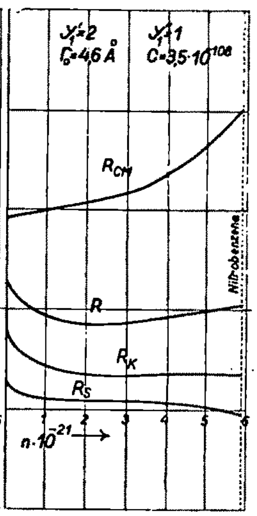

Fig. 3

Fig. 1. Reducing factors calculated from experimental data using the Lorentz local field

Fig. 2. Reducing factors calculated from experimental data using the Onsager local field

Fig. 3. Theoretical reducing factors calculated assuming the existence of three kinds of coupling forces. To be compared with Fig. 2

I was able to obtain a reasonable quantitative agreement between theory and experiment using the Onsager local field and assuming in addition the above-mentioned coupling of kind III. This coupling results from the mutual interaction of the transitory quasi-antiparallel pairs formed by the coupling of kind II. The total electric moment is thus increased.

It is significant that the agreement between the theory and experiment is assured for all four phenomena considered by one set of four constants common to all the formulæ. The theoretical curves are shown in Fig. 3, in which the numerical values of the constants are also given. Comparing the experimental curves (calculated on the basis of Onsager's local field, Fig. 2) with the theoretical ones (Fig. 3), it can be seen that many characteristic features of the experimental curves are well reproduced by the theory.

Recently, I calculated on the same assumptions the lowering of the freezing point of dilute solutions of polar liquids in non-polar solvents. Agreement with the experimental data has been obtained without introducing any new constant.

A full account of this work will be published elsewhere.

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[1] Piekara, A., *Proc. Roy. Soc.*, A, **172**, 360 (1939).

[2] Piekara, A., and Piekara, B., *C.R. Acad. Sci., Paris*, **203**, 852 (1936) *Phys. Z.*, **38**, 671 (1937).

[3] Onsager, L., *J. Amer. Chem. Soc.*, **58**, 1486 (1936).

[4] Fowler, R. H., *Proc. Roy. Soc.*, A, **149**, 1 (1935).

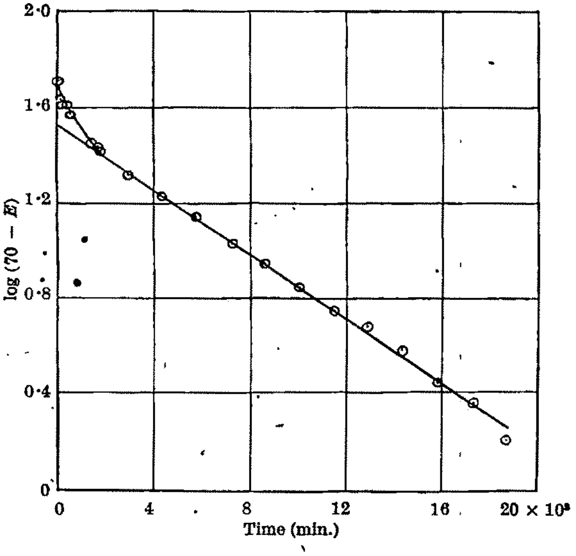
[5] Debye, P., *Phys. Z.*, **36**, 100 (1935).

[6] Vide König, H., *Ann. Phys.*, **31**, 289 (1938).

Structure of the Keratin Molecule

WHEN wool fibres of uniform cross-sectional area are stretched extremely slowly in saturated air at 18° C., they break at 70 per cent extension[1]. Confined in its early stages to the amorphous regions of the fibre, extension occurs by the transformation of the crystalline phase from the α- to the β-configuration at extensions above about 25 per cent[2]. It has been found possible to disentangle these two processes, and obtain a closer insight into the α-β-transformation process, by studying the extension of wool fibres under constant *stress*[3] in saturated air at low temperatures. Under a stress of $6\cdot89 \times 10^{5}$ gm./cm.^{2} at 21° C., for example, the immediate extension of the fibre (3 minutes after the application of stress) was 19·4 per cent, rising to 30·2 per cent after 300 minutes and 68·4 per cent after 18,682 minutes. As might be expected, there is an exponential approach to the limiting extension of 70 per cent, as shown in the accompanying figure, where log $(70 - E)$ is plotted against time.

Since the linear relationship is not obeyed in the early stages, where extension occurs mainly in the amorphous phase, and since extrapolation of the line indicates an initial extension of 35·6 per cent, it is clear that extension of the fibre over the period from 1 to 13 days is due to slow unfolding of the molecules of α-keratin in the crystalline phase. The slope (k) of the line in the figure is a measure of the rate of unfolding, and by determining k at different temperatures with wool fibres under various stresses, the activation energy associated with the α-β-transformation can be calculated.



Under a stress of $6\cdot89 \times 10^{5}$ gm./cm.^{2} at 21° C. and 13° C., the values of k were $6\cdot76 \times 10^{-5}$ and $2\cdot65 \times 10^{-5}$, respectively, corresponding to an activation energy of about 20 kcal. This, in turn, agrees with Astbury's conception[4] of the nature of the intramolecular fold in α-keratin, for the opening of each fold involves the breakdown of three hydrogen bonds between —CO— and —NH— groups.

Determinations of the rate of extension of wool fibres under constant stress thus provide a simple and attractive means of studying the structure and reactivity of α-keratin, and the above experiments are now being extended to wool and other fibres under a wide variety of conditions.

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[1] Speakman, *J. Text. Inst.*, **17**, T457 (1926).

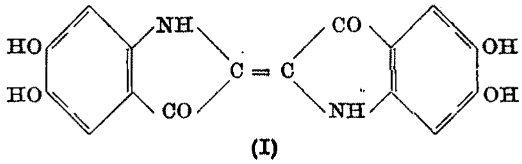
[2] Astbury and Street, *Phil. Trans. Roy. Soc.*, A, **230**, 75 (1931). Astbury and Woods, *Phil. Trans. Roy. Soc.*, A, **232**, 333 (1933).

[3] Speakman, *J. Text. Inst.*, **17**, T472 (1926).

[4] Astbury and Bell, *Nature*, **147**, 696 (1941).

Constitution of Melanin

IT has been suggested recently[1] that 5 : 6 : 5′ : 6′-tetrahydroxy-indigo (I), or a quinone or semi-quinone derived from it, is an important constituent of melanin, the black pigment produced by the oxidation of tyrosine and 3 : 4-dihydroxyphenylalanine[2].



(I)

It was therefore of interest to synthesize the tetrahydroxyindigo by an unambiguous route and to compare its properties with those of melanin. An attempt to synthesize the compound was made by Hayduck[3], who unsuccessfully tried to demethylate a product which he considered to be 5 : 6 : 5′ : 6′-tetramethoxyindigo ; however, he showed later[4] that the tetramethoxy compound in question was, in fact, the 6 : 7 : 6′ : 7′ isomer. Clemo and Weiss (*loc. cit.*) attempted to remove the methylene groups from piperonal-indigo; but this procedure was also unsuccessful, only products insoluble in aqueous alkali being obtained.

The starting material used in the present synthesis was 6-nitroprotocatechuic aldehyde, which was prepared by Parijs[5] by the action of fuming nitric acid on 6-nitropiperonal diacetate in acetic anhydride solution. On repetition of this work it was found that the yields obtained were much smaller than those described, and the process could not be adapted for larger scale preparation. 6-Nitro-piperonal was found to be remarkably resistant to demethylenation by the usual methods, but it was eventually found that the methylene group could be removed successfully by heating with an excess of pyridine hydrochloride to 160–170°, and this appears to be the only practicable method.

When the disodium salt of 6-nitroprotocatechuic aldehyde was treated with two molecules of chloromethyl ether in benzene, 3 : 4-bis-(methoxymethoxy)-6-nitrobenzaldehyde was obtained, and this compound on treatment with acetone and alkali gave 5 : 6 : 5′ : 6′-tetra(methoxymethoxy) indigo in good yield. Hydrolysis with dilute mineral acid then yielded the required tetrahydroxyindigo. The product was a greenish-black powder, slightly soluble in pyridine and nitrobenzene with a greenish-blue colour. It was readily soluble in aqueous sodium hydroxide giving an intense permanganate-violet solution, and was reprecipitated unchanged by addition of acid. Acetylation with acetic anhydride and pyridine gave the tetra-acetyl derivative which crystallized well from nitrobenzene. On reduction with sodium hydrosulphite and alkali a yellow vat was obtained, re-oxidizing readily in air to give a violet solution.

The tetrahydroxyindigo is thus quite different from melanin, which is slightly soluble in alkali with a greenish-brown colour. Furthermore, it is scarcely possible that melanin can be a quinone or semiquinone derived from tetrahydroxyindigo, since such a compound would undoubtedly be reduced by sodium hydrosulphite and alkali to the same leucocompound as that formed from the tetrahydroxyindigo itself: this latter is certainly not obtained from melanin, as the hydrosulphite vat from this substance does not re-oxidize to give the characteristic violet colour shown by alkaline solutions of the tetrahydroxyindigo.

Full details of this work will be published elsewhere in due course.

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[1] Clemo and Weiss, *J. Chem. Soc.*, 702 (1945).

[2] Raper, *Biochem. J.*, 21, 89 (1927); 31, 2162 (1937).

[3] *Ber.*, 36, 1528 (1903).

[4] *Ber.*, 36, 2930 (1903).

[5] *Rec. Trav. Chim.*, 49, 18 (1930).

THE interesting method used successfully by Harley-Mason for demethylenation is similar to that worked out in Germany[1] during the War using pyridine hydrochloride for the demethylation of phenol ethers, which was unknown to us at the time of our work.

The conclusions reached in our paper were largely based on the determination of the oxidation equivalents by H. S. Raper. Accepting Raper's figures, the indigoid formulation suggests itself as the most likely one on the basis of our experiments and on the known behaviour of dihydroxyindole. As implied in our paper, and bearing in mind the marked instability of catechol compounds under biological *p*H conditions, it is very unlikely that the hydroxyl groups are present in the free state.

If, on the other hand, one admits higher oxidation figures than those given by Raper, then clearly there is the possibility of polymerization products of indigoid type, for example, with a dehydrotype as polymerizing unit.

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[1] Prey, V., *Ber.*, 75B, 350 (1943).

Existence of Cupric Hexammino Sulphate

WHILE the hexammino compounds of the halides, nitrates and other salts of copper are well known, nothing seems to be on record regarding the existence of cupric hexammino sulphate. In recent communications, Dey and Bhattacharya[1] have described a new method for the isolation of cupric pentammino sulphate, from ammoniacal solutions of cupric sulphate. In other publications from this laboratory, Dey has recorded the results of the conductometric measurements of mixtures of cupric nitrate[2] or chloride[3], with ammonium hydroxide solutions, of various compositions. The conductometric curves gave breaks corresponding to three, four, five and six molecules of ammonia for one molecule of the copper salt, thus affording the evidence for the existence of tri-, tetra-, penta- and hexa-ammino cupric compounds. In the case of cupric ammino sulphates, however, the triammino compound is not found, whereas the three other compounds are formed. The changes in the extinction coefficients of mixtures have also been studied by means of a Nutting's spectrophotometer, and the results confirm those obtained by the electrical conductivity method. We thus find that these results indicate the definite existence of cupric hexammino sulphate, as well, in an ammoniacal solution of cupric sulphate.

I am indebted to Dr. A. K. Bhattacharya, head of the Department of Chemistry, University of Saugor, for his interest in this work.

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[1] Dey and Bhattacharya, *Curr. Sci.*, 14, 201 (1945); *Proc. Ind. Acad. Sci.*, A, 23, 259 (1946).

[2] Dey, *Nature*, 158, 95 (1946).

[3] Dey, *Curr. Sci.*, 15, 317 (1946).

Statistical Methods in Chemical Analyses

IT is well established that many of the distributions met in biological work approximate to the normal, and the modern developments of statistics are associated with this fact. Most of the techniques are dependent for their validity, to a greater or less extent, on the goodness of the normal equation as a description of the experimental distributions. Since there cannot be any *a priori* reasons for expecting distributions in chemical work to be normal, and there seems to have been very little investigation of the natures of the distributions actually occurring, application of methods which presume normality may be highly dangerous.

With the view of ascertaining whether such methods can be applied, I have carried out an investigation of a number of distributions arising in the course of analysing chemically a wide variety of the products of industry in the Chemical Inspection Department of the Ministry of Supply. The products included metals, alloys, 'pure' and 'commercial' chemicals, mixtures, etc., from thirty or forty different firms. Some 250 distributions, involving about 50,000 chemical analyses, have been examined. The analyses were of various kinds, such as determinations of impurities present as traces or in larger amounts, assays of substances both pure and crude, and measurements of characteristics, by chemical and physical methods, such as are ordinarily carried out in the control laboratories of chemical industry.

It was found that only 10–15 per cent of these distributions could, for practical purposes, be regarded as normal. The remainder were significantly non-normal. Some 15 per cent of the distributions were of the form of truncated normal curves. These may, of course, be treated as the tails of normal curves which can be fitted either (i) graphically, (ii) by Pearson's method of the moments about the stump, or (iii) by a least squares method which has been developed.

About 10 per cent of the distributions were symmetrical ($\beta_1 \doteqdot 0$) but showed leptokurtosis ($\beta_2 > 3$) to an appreciable extent, and the χ^2-test for the goodness of fit of a normal equation gave values of $P < 0{\cdot}01$. Thus they could not be described satisfactorily by equations of the normal form. Fitting of curves, such as Pearson's Type III, did not prove to be entirely satisfactory. A mathematical model, which is the sum of the products of two Poisson distributions, has been worked out, and it seems that distributions of this type may usefully be described by the equation

$$y_x = I_{|x|}(\sigma^2) \,.\, \exp(-\sigma^2),$$

in which $I_{|x|}(\sigma^2)$ is a Bessel function of the second kind.

Since $|x|$ is used, the curve is symmetrical about $x = 0$ and extends from $-\infty$ to $+\infty$. The integral is unity, and hence the expression may be used as a probability distribution.

The lower moments of this distribution are $\mu_2 = \sigma^2$; $\mu_3 = 0$; $\mu_4 = 3\sigma^4 + \sigma^2$, and the coefficients $\beta_1 = 0$ and $\beta_2 = 3 + \frac{1}{\sigma^2}$.

Since

$$\sigma_\sigma = \frac{\sigma}{\sqrt{2n}} \left(1 + \frac{\beta_2 - 3}{2}\right)^{1/2},$$

we have for the standard deviation of the standard deviation of this distribution

$$\sigma_\sigma = \frac{\sigma}{\sqrt{2n}} \left(1 + \frac{1}{2\sigma^2}\right)^{1/2}.$$

The expression in brackets differs from unity by more than five per cent when $\sigma^2 = 5$. Hence, for large samples, the usual expression for the standard deviation of the standard deviation cannot be used when $\sigma^2 < 5$. In the actual distributions studied, it has been found that the degree of leptokurtosis is considerably greater than this. The position in regard to small samples is being investigated.

Some 10 per cent of the distributions were truncated leptokurtic curves apparently derived from the above parent distribution.

About 20–25 per cent of the distributions were *J*-shaped. It has been found that many of these may usefully be described by an equation of the form

$$y_x = \frac{1}{\sqrt{2\pi . a x}} \left(\frac{\bar{x}}{x}\right)^{ax} . \exp a\,(x - \bar{x}),$$

the parameters of which can readily be calculated.

Some 20–25 per cent were skewed. Some of these may be treated by logarithmic or other transformations of the variable, but these methods are not entirely successful. A promising approach to a generalized equation for this type of curve is now being explored. This equation is of the form

$$y_x = \left(\frac{\sigma^2 + \bar{x}}{\sigma^2 - \bar{x}}\right)^{x/2} \cdot I_{|x|}\left(\sqrt{\sigma^4 - \bar{x}^2}\right) . \exp(-\sigma^2),$$

of which the lower moments are

$$\mu_2 = \sigma^2;\ \mu_3 = \bar{x};\ \mu_4 = 3\sigma^4 + \sigma^2.$$

The remainder of the distributions were irregular. A few were bi-modal and have yielded to analysis into the sum of two normal distributions.

From the data under consideration it has been possible to associate certain types of chemical data with the above different kinds of distribution.

The principal conclusions of this investigation are: (1) great caution must be exercised in applying the ordinary simple statistical methods to the data of chemical analysis; (ii) many of the distributions depart radically from the normal and are possibly more correctly to be regarded as forms of 'rare occurrence' distributions; (iii) the continuous nature of the variable is, in many cases, probably superficial, and it should, more correctly, be regarded as a discontinuous variable.

It is hoped shortly to publish this work in full elsewhere. I wish to express my appreciation to Prof. H. Levy and Prof. H. V. A. Briscoe for advice and encouragement, and to the Chief Scientist, Ministry of Supply, for permission to publish the work.

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Transference of Vitamin D from the Female Rat to Her Young

No report has been found of the ability of the rat to transfer ingested vitamin D to the milk. The ability to do this is known to be limited in the human being[1,2,3,4], in the cow[5,6] and in the ewe[7]. An accidental and most unfortunate experience in this laboratory has provided a certain amount of information on the transmission of vitamin D from the diet to the milk of the rat.

The diet of the stock colony of rats[8] contains 10 per cent of full-cream dried milk powder. Litters intended for vitamin D tests are weaned at 21–23 days of age and fed on the stock diet until they are 55–65 gm. in weight, that is, for about ten days. If they are then given the Steenbock rachitogenic diet (2,965)[9] for a preparatory period of three weeks, they develop a severe degree of rickets and are suitable for use in determinations of vitamin D. A further period of ten days on the same diet together with a small dose of the standard or vitamin-containing substance results in the formation of a line of healing in the metaphyses of the ulnæ and radii with well-defined areas of uncalcified cartilage above and below it.

In August 1945 the healing as evidenced in the 'line test' gradually became very high, and by the end of September the bones showed very little signs of development of rickets after four and a half weeks on the rachitogenic diet. As short periods of apparent inability to produce rickets had previously been encountered, possible causes and methods of counteraction were explored with negative results. As the rats were kept during this period in a basement room illuminated solely by artificial light, the effect of excessive daylight suggested by previous experience to be the most probable cause of trouble was ruled out. The fresh cow's milk and liver were withheld from the diet of the stock colony, but with no apparent effect on the rachitic condition of the young when given the rachitogenic diet. In fact, it was observed that rats fed on the rachitogenic diet grew well and showed obvious signs of well-being. Moreover, in place of the usual seasonal drop in the number of litters produced by the colony in the later months of the year, the reproduction-rate was well maintained. At the end of December it was discovered with dismay that the dried milk used in making the stock diets for the breeding colony had been fortified by the producers with vitamin D. Deliveries in August, September and October were acknowledged to have been fortified; earlier ones were not determined. Assuming the vitamin D content of the milk to be 10 I.U. per gm. as now claimed for all 'National dried milk', an animal consuming 15 gm. of stock diet daily would thus be receiving about 15 I.U. of vitamin D a day.

The fortified milk was, of course, replaced by unfortified at the beginning of January 1946. The reappearance of rickets in young rats fed on the rachitogenic diet was followed by putting on fresh litters each week and examining some rats of each, week by week for six weeks, by the 'line test' technique. A mild degree of rickets began to develop in the young rats about the end of February, and the rachitic condition gradually became more and more severe until at the beginning of May it was severe enough to use the rats for vitamin D determinations after the usual three weeks preparatory period. During the later part of this long time of examining 'no dose' rats, a few cases of apparently spontaneous healing were observed; but on investigation it was found that the rats in which it occurred had eaten the greater part of one of their number while they had been housed all together in one cage. The healing in these rats may have been brought about by the ingestion of residual vitamin D in the eaten rat or of part of its skeleton, which might have been enough to upset the Ca : P ratio of the diet and bring about healing independently of the presence of vitamin D.

It might have been expected that, as soon as unfortified dried milk was again given to the colony, the young rats would develop the usual intensity of rickets when given the rachitogenic diet. They would surely have done so if the source of their vitamin D had been only the stock diet they had eaten between weaning and receiving the rachitogenic diet. However, successive litters of young rats, taken from stock week by week and prepared as described, developed no rickets at first, and only as time went on developed at first a mild degree of rickets, then a more severe condition, and finally after about four months a state of rickets comparable with that we had previously produced by the same treatment. This indicated clearly that the young rats must have obtained supplies of the vitamin from the doe, either via the placenta or from the milk during lactation, and stored it somewhere for use as needed. The severity of the rickets developed in the different litters after four months of unfortified dried milk in the stock diet did not vary much, and we were able to proceed with the determination of vitamin D in the usual way.

It is tempting to try to estimate the adult doe's need of vitamin D from this experiment, but there are too many unknown factors in it. The amount of vitamin D taken in by the does during the four months when the diet contained fortified dried milk was probably more than 2,130 I.U. (that is, 15 I.U. a day for 142 days from the dried milk, and an unknown amount, though small, from the rest of the diet). But there is no indication of how much of this was absorbed or stored or used up by the rat while she was being fed on the enriched diet. She certainly had stored some of it, but there is no indication of what her store was when unfortified dried milk was again given in the diet. We only know that the store was exhausted within a further four months, during which each doe probably had two litters and gave to her young decreasing amounts of vitamin D as time went on. That the doe would probably benefit by receiving more vitamin D than the stock diet usually contains is indicated by the fact already mentioned that the breeding of the colony (as evidenced by the number of litters born) was higher during the winter months of 1945–46 than in any previous winter of the colony's existence.

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Heat Treatment and the Biological Value of Soya-bean Protein

FROM the observations of other workers[1-12], it appears that the increase in biological value in heat-treated soya-bean may be due to three reasons: (1) heat treatment increases the availability of cysteine and methionine due to some change in the structure of the protein; (2) proteolytic inhibitor is inactivated by heat treatment; (3) any toxic factor which may be present other than the inhibitor is destroyed by heat.

The present study was conducted to see whether heat treatment is essential for improving the biological value of soya protein. For this purpose pure glycinin was separated from defatted soya-bean and its nutritive value compared to that of raw bean. The extraction was carried out at pH 7·0 with 6 per cent sodium chloride, and the aqueous extract was dialysed and precipitated further by bringing down the reaction to pH 4·2. The precipitated glycinin was centrifuged out. The biological value of glycinin and the proteins in raw and autoclaved soya-bean were compared by determining the growth in young albino rats over a period of eight weeks. The protein was fed at 10 per cent level. The results obtained are as follows:

Source of protein	Protein consumed (gm.)	Gain in weight (gm.)	Gain in weight (gm.) per gm. protein consumed
Raw soya-bean	29·1	22·6	0·78
Glycinin	31·5	48·8	1·55
Autoclaved soya-bean (15 lb. for 1 hr.)	30·6	44·7	1·46

The results show that heat is not essential for enhancing the nutritive value of the protein in raw soya-bean as the glycinin is more effective in promoting growth than autoclaved soya-bean.

The proteolytic inhibitor and also any toxic factor which may be present in raw soya-bean are eliminated in the process of preparing glycinin. This is supported by the observation that the acid extract of soya-bean retards the growth of rats provided with a well-balanced diet.

Further studies are in progress to determine the nature and mechanism of action of the factors present in the extract.

Our thanks are due to Prof. V. Subrahmanyan for his interest in the work.

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Solvent-treated Cellulose Acetate as the Stationary Phase in Partition Chromatography

Silica gel and cellulose have a wide application as stationary aqueous adsorbents in partition chromatography, the moving phase being an organic solvent. For many purposes a stationary organic phase is desirable, and the use of solvent-treated organic polymers to serve as supporting media for organic solvent phases has, therefore, been investigated.

Cellulose acetate, as ½-in. staple filaments, when treated with *n*-butyl alcohol at 50° C. for thirty minutes, cooled, filtered, pressed and washed with saline to remove excess solvent, serves as a stationary organic solvent phase. 50 gm. of this material, packed tightly in a column, was sufficient adsorbent to extract exhaustively cresol and benzoic acid from 2 litres of an aqueous 0·1 per cent cresol solution, saturated at room temperature with benzoic acid, and with addition of sodium chloride. The extracted organic substances could be eluted with aqueous alkaline eluents or by a suitable organic solvent such as ether.

A. E. Aréa Leão *et al.*[1], in the extraction of penicillin from culture media filtrates, used a suspension of "solvent-activated cellulose acetate" prepared by shaking an aqueous suspension of cellulose acetate with addition of a small proportion of suitable solvent, for example, chloroform. A chromatographic method was not used by them, and it is possible that the new technique described might prove to be an improvement on the usual solvent extraction procedure.

In general, suitable adsorbents may be prepared by treating the polymer with a solvent swelling agent at a temperature just below that required to cause aggregation of the swollen polymer particles. Cellulose acetate may be regarded as the prototype of a wide range of polymers that could be utilized in the manner described. W. Coltof[2] may be consulted for comprehensive data on the effect of solvents on cellulose acetate. A wide industrial application of this technique to solvent-water partitions is obvious.

I wish to thank British Celanese, Ltd., for generous gifts of polymers used in this department, and for information.

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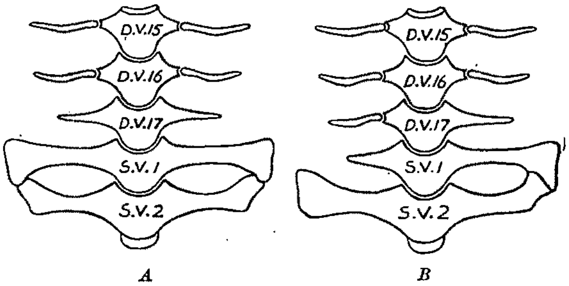
Sacral Ribs of Lacertilia

Some authors consider the lateral processes of sacral vertebræ in Lacertilia to be fused sacral ribs. Others deny this view and consider them to be nothing but well-developed transverse processes. While investigating the vertebral column of several individuals of the lizard, *Agama stellio*, I found one of them which supports the first view.



Agama stellio. Ventral view of the last three dorsal vertebræ (*D.V.* 15–17) and two sacral vertebræ (*S.V.* 1 and 2) of two different individuals

In *Agama stellio* the last dorsal vertebra possesses a pair of ribs which are completely fused with the centrum. There are two sacral vertebræ, each having a pair of well-developed lateral processes (Fig. 1 *A*). But in this particular individual, the last dorsal vertebra possesses two ribs, one of which is movably articulating with the centrum as all other preceding ribs do, while the other is completely fused with the centrum. The first sacral vertebra possesses two processes. The process of the right side is short, weakly developed and quite similar to the fused rib of the last dorsal vertebra referred to above. The process of the left side, on the other hand, is long, well-developed and resembles the processes of ordinary sacral vertebræ (Fig. 1 *B*). The right process of the first sacral vertebra can be easily homologized with the fused rib of the last dorsal vertebra, and the same is, then, true for the left process.

Therefore, the lateral processes of the sacral vertebræ of Lacertilia should be considered as sacral ribs which have fused with the centra of their vertebræ, and which have become greatly enlarged so as to perform the important function of supporting the pelvic girdle.

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ASPECTS OF STRUCTURAL ENGINEERING

THE Bossom Gift Lecture for the current session, forming part of the programme of public lectures arranged by the Chadwick Trust, was delivered on November 26, 1946, at the Institution of Structural Engineers by this year's president of that body, Prof. H. J. Collins, Chadwick professor of engineering at University College, London. Under the title of "Some Aspects of Structural Engineering", Prof. Collins dealt broadly with the post-war building situation in Britain, with special reference to the report of the mission (on which Sir Alfred Bossom, who presided at the meeting, had served) which visited the United States of America in 1943, to the present policy of the Government on housing, and to the 'avalanche of paper' in the form of building studies, codes, standard specifications and revised regulations with which those who design and construct in these days are expected to comply. Having but recently resumed civilian duties after five years of active service in the Royal Engineers, Prof. Collins chose to refer by question rather than by answer to certain aspects of building and constructional engineering which marked the contrast between post-war and pre-war years.

Prof. Collins said that six non-constructive, indeed extremely destructive, years had brought the urgency of the need for building to a tremendous pitch, intensified by the general desire that social conditions should in the process be improved. Domestic housing is undoubtedly of the first importance ; it is necessary to employ as economically as possible both labour and material, and to devise substitutes for all materials which are not indigenous. Types of construction other than housing are also urgently needed. When work on these is resumed :

What will be the effect, on the progress of construction, of uncertainties both as to construction dates and as to the loads and stresses which will then be permissible ?

The economical use of materials is a measure of the skill of the engineer, but it takes from five to ten years to train a civil engineer, and none was being trained during the last three years of the War. It is therefore more than ever necessary to keep the knowledge of trained engineers up to date.

Are the results of advances in research being made readily available to the engineer ?

The supreme achievement in structural design is to attain simplicity approaching functional perfection. Under State control, the tendency might well be away from simplicity, but the attempt might nevertheless be made to overcome the shortage of engineers by standardizing methods of design. To control design by legislation must tend to change its governing principle from individual initiative and considered thought to rampant empiricism, and so put an end to scientific progress.

How far can standardization be carried without tending to kill initiative ? Should the establishment of such standards as might be necessary be made the responsibility, not of a Government department, but of the appropriate engineering professional institution ?

Ruskin showed that ancient building was often made wonderful by the marriage of science and art. Is the light of the Seven Lamps of Architecture so dim to-day, asked Prof. Collins, as to need the further illumination of some 174 building studies, codes and standards ?

Can studies, codes and regulations do away with the need for independent architects and for properly qualified structural engineers ?

A national policy governing the design and construction of buildings must be based on one of two alternatives : either it might allow any person to call himself an engineer, control him by regulations, and maintain conformity to these by a system of inspectors : or it might restrict the making of designs to selected persons of proved competence, and insist that such persons be qualified by institutional examination and/or by registration. Hitherto, standards of qualification for inspectors and systems of inspection in different parts of the country have varied considerably.

Could we accept as sound a national uniform set of building regulations ? Would registration act more for the national good or for the benefit of one or more groups of professional men ?

Prof. Collins recalled his experiences in 1939, when he assisted in forming Construction and Artisan Works Companies of the Corps of Royal Engineers from 600–800 building craftsmen who had answered the urgent call for volunteers in the Christmas broadcast of that year. He had served with those men in three theatres of war and lived with them for five years. By their training as apprentices, they had been made amenable to suggestion ; because of the pride each felt in his craft they required little supervision ; because they were used to working under the supervision of foremen they accepted discipline automatically. If the spirit of these volunteer craftsmen were present in the building industry to-day, then delays in production must come from other causes than their lack of willingness to deliver the goods.

In the course of general post-war increases in wages in the building industry, perhaps semi-skilled workmen and labourers had been unduly favoured at the expense of the more highly skilled workmen.

Were the post-war differences between the wages of craftsmen and of unskilled labourers sufficient to offset the drawbacks and hardship involved in the long apprenticeship required of the skilled trades ?

In conclusion, Prof. Collins referred briefly to the present position of research in relation to modern building, and mentioned several promising lines of possible development : the use of photogrammetry in town and country planning, the application to structural engineering of electrical methods of measuring strains which have proved successful in the aircraft industry, and the application of supersonic frequencies to the measurement and consolidation of materials.

The outstanding work which has been done and is still being done by the Government research departments, and by the institutions which they sponsor, should be supplemented by a pool of apparatus for research purposes, and by grants of fellowships to men who, by combining with research a limited amount of teaching, would hand on knowledge both of facts and methods to a wide circle. These considerations led to his last question.

In post-war reconstruction and planning, are the universities and technical colleges playing their full part in the advancement of building science and of research in structural engineering ?

Some of Prof. Collins' questions were purely rhetorical, and indicated no doubt as to the answer he might have given: others would be difficult indeed to answer at the present time; but all referred to problems which demand solution, and were aimed at stimulating thought and decision in those who must either take a lead in directing the future or perforce follow the direction of others less reticent.

Reading between the lines of Prof. Collins' questions, it is not difficult to trace the hope he had expressed with less reserve in the conclusion to his presidential address to the Institution of Structural Engineers a few weeks previously, that the "young members will in the future live to see the sun rise over the unshackled initiative of structural engineers; engineers who carry no fetters of Government regulation, no manacles of Local Authority restriction; but who have the free and unchecked initiative to plan and design that belongs by right to members of a profession that bears such heavy responsibility to society and to mankind".

STANLEY B. HAMILTON

ANTIBIOTICS

THE number of publications which record work on antibiotics has become so large that frequent evaluations of the progress of our knowledge of these substances have become essential. A conference devoted to these substances was held by the New York Academy of Sciences in January 1946, and the papers have now been published (*Ann. N.Y. Acad. Sci.*, **48**, Art. 2, 31; 1946). It is impossible to summarize these papers here, but a note on them will indicate their scope. They are arranged in two sections, one microbiological, the other pharmacological.

Dr. S. A. Waksman introduces the former with a paper on the contributions made by the microbiologist. M. J. Johnson describes the metabolism of penicillin-producing moulds, and K. B. Raper discusses the development of improved forms of them. W. J. Robbins, F. Kavanagh and Annette Hervey discuss the production of antibiotic substances by Basidiomycetes, S. A. Waksman, A. Schutz and D. M. Reynolds write on the production of antibiotic substances by Actinomycetes, and J. W. Foster and H. B. Woodruff deal with antibiotic substances produced by bacteria.

The pharmacological section is, with the exception of an article on the pharmacology of penicillin by G. Rake and A. P. Richardson and one on its use in the United States Navy by W. W. Duemling, devoted to the pharmacology of streptomycin and streptothricin. The first article on this subject is by H. Molitor. In another article H. J. Robinson discusses the absorption, excretion and chemotherapy of these two substances. The action of streptomycin on various micro-organisms and its use for the treatment of some non-tuberculous infections are discussed by E. Pulaski, A. Kleinman and G. G. Duncan. Its action on the bacillus of tuberculosis has given rise to the hope that it will be useful for the treatment of this disease; but the article here printed by H. C. Hinshaw and W. H. Feldman on the use of streptomycin for the treatment of clinical and experimental tuberculosis emphasizes the opinion expressed in an "Annotation" in the *British Medical Journal* (906, Dec. 14, 1946), that "it is at present quite uncertain whether streptomycin will prove, in the long run, to have great therapeutic value in tuberculosis". The same "Annotation" announces that committees appointed by the Medical Research Council will, when enough streptomycin becomes available, conduct trials of streptomycin for the treatment of types of tuberculosis likely to give clear evidence of its uses and limitations, and also trials of its action on certain non-tuberculous infections. The same cautious opinion of its possible efficacy for the treatment of tuberculosis is expressed by Dr. P. D'Arcy Hart in his Mitchell Lecture delivered to the Royal College of Physicians (*Brit. Med. J.*, 805, Nov. 30, and 849, Dec. 7, 1946) on the "Chemotherapy of Tuberculosis", a remarkable lecture with a full bibliography, which is discussed in an editorial article in the *British Medical Journal* (862, Dec. 7), together with the Harben Lectures on the same subject delivered by Dr. W. H. Feldman, of the Mayo Clinic. An interesting recent paper by D. G. Madigan, P. N. Swift and G. Brownlee (*Lancet*, 9, Jan. 4, 1947) indicates that what these authors call "the potential and actual toxicity of streptomycin" needs to be watched and investigated further.

Brief reference may also be made to the address given to the American Chemical Society in October of last year by Dr. L. C. Craig, of the Rockefeller Institute for Medical Research. Dr. Craig described a new method of isolating various forms of penicillin which frees the chemist from dependence upon boiling and melting points. This method, which is called 'counter-current distribution', uses the partition coefficient, which is a ratio indicating the diffusibility of a substance into cell protoplasm. The method employs a system of multiple transfers of the substance being studied through a series of separating funnels, so that the mathematics of the binomial theorem may be applied to interpret the results. Dr. Craig claimed that the method has disclosed at least seven types of penicillin and has indicated that there are many more. The method has also been applied to synthetic antimalarial substances.

G. LAPAGE

CANADIAN RESEARCH IN GEODESY AND GEOPHYSICS

THE National Research Council of Canada has re-organised its Associate Committee on Geodesy and Geophysics (formed in 1945) and has given it authority to gather information on, and to direct and co-ordinate research in the field of, "geodesy and geophysics, including meteorology, hydrology, oceanography, seismology, vulcanology, magnetism, terrestrial electricity, tectonophysics, gravity, and any other subjects necessary to an integrated study of earth physics and geophysical prospecting". The chairman of the Committee is Prof. J. T. Wilson, professor of geophysics, University of Toronto.

The Committee is being provided with funds for the award of grants in aid of specific research projects to persons competent to direct work in this field and who have the required laboratory facilities at their disposal. Much of the work that interests the Committee is carried out as part of their normal duties by several Government departments and is paid for by those departments.

The integration and stimulation of geophysical work in Canada are desirable for several reasons: (i) geophysical methods of mineral and oil prospecting have assumed great importance, and this will continue; (ii) the Pre-Cambrian shield is the biggest and richest area of basement rocks in the world, and its study will throw light on earth structure as well as provide minerals; (iii) there are large areas of potentially useful oil-bearing rocks in western Canada; (iv) no other country is in so interesting a position geophysically, since Canada includes the north magnetic pole, and extends to the north geographic pole, and nearly to the magnetic axis; a larger part of the maximum auroral belt crosses Canada than any other country; (v) ionospheric studies for radio prediction have increased greatly during the War, and there are seven Canadian stations; the auroral belt will always produce peculiar effects; (vi) magnetic observations are lacking in northern Canada, where they are of value for navigation and of great interest near the magnetic pole.

More than a score of projects have already been initiated and further investigations are planned. One of the most fruitful subjects aided by the Committee has been the development of an airborne magnetometer. Fluxgate magnetometers were built by the National Research Council during the War; but these, it was known, would require extensive modifications before they could be adapted to airborne use. An early type was fitted to aeroplanes flying on Exercise Musk-Ox, in order to gain experience. In the United States, the Geological Survey had succeeded in adapting to geological use the magnetic airborne detector used in anti-submarine work, and it was thought this instrument would be suitable for use in Canada. The National Research Council obtained three sets from the United States Navy and modified them so that they will be available to the Department of Mines and Resources for use in Canada during the summer of 1947. Arrangements were made for a United States Geological Survey crew to bring a magnetometer to Canada and to make trial magnetic surveys of part of the Sudbury basin and of Louvicourt township. These surveys have been calculated, and the results will be published by the Geological Survey of Canada in co-operation with the United States Geological Survey.

In another project, mining and prospecting companies in Canada have co-operated with the Committee by supplying plans of magnetic readings for some of their properties. The Bourlamagne region in Quebec was chosen as a suitable area on which a regional map might be prepared from the magnetic survey data supplied by mining companies. Magnetic data for five townships have now been compiled and contoured. Comparison with the geology of the area will be made in a report now being prepared for publication.

A seismic study of the crust of the earth using rock-bursts as a source is projected for this season.

Geophysical work will continue to be done and paid for by existing departments, companies, and universities; but all this work will now be co-ordinated by the Associate Committee on Geodesy and Geophysics of the National Research Council. The Committee's work will not overlap that of the Geophysical Committee of the Geology Division of the Canadian Institute of Mining and Metallurgy, which deals with matters such as assessment laws, customs and tax rates, methods of procedure and professional ethics.

Steps have been taken to hold open meetings of the Associate Committee on Geodesy and Geophysics, the first of which was in connexion with the annual meeting of the Canadian Institute of Mining and Metallurgy at the National Research Building in Ottawa on January 23, 1947. The Committee proposes also to start publishing a bibliography on Canadian geophysics which will include reports on its activities.

RELAXATION METHODS APPLIED TO ENGINEERING PROBLEMS

IN this latest instalment* of Dr. R. V. Southwell's application of his relaxation method for the solution of the differential equations of physics, the problems treated are of a kind which are particularly intractable by classical methods—problems relating to the flow of a fluid having one or more free surfaces in a gravitational field. In addition to their practical interest, the results obtained present in an acute form the fundamental question of the extent to which the numerical approach can disprove the possibility of a particular type of solution.

When the relaxation method reveals the existence of a hitherto mathematically unknown flow pattern (as it does in this paper in connexion with the wakes formed by entrained air behind a cylinder or sphere travelling through a fluid), it can be shown that this solution satisfies all the required conditions, and is therefore authentic. But when the computation fails to reveal the existence of a solution which on general grounds might be expected to exist, to what extent is it proved that no such solution does in fact exist? Such a case arises in this paper in the treatment of the stream-line distribution caused by the passage of an inclined plane of infinite width over the surface of a fluid of finite depth. Apparently, in this two-dimensional problem it is impossible for the depth of the fluid to be the same before and after the passage of the plane—a result which may appear to be contrary to expectation. Perhaps the best approach to this question is to regard the relaxation method as an experimental rather than as a mathematical technique. The authors repeatedly stress the tentative nature of the relaxation process, and perhaps their results can be seen in the proper perspective if they are regarded as experiments carried out, as real experiments so seldom are, under ideal mathematical conditions. The failure of such an experiment to reveal a certain phenomenon does not disprove its existence; but a sufficient number of such experiments, carried out under various conditions, and all giving a negative result, may be taken as demonstrating that the phenomenon does not occur in practice—which for the engineer is equivalent to a disproof of its possibility.

The paper also contains numerical solutions to a number of other problems, including the well-known case of the circular weir-Borda flow in three dimensions. From the point of view of computational technique, these problems are among the most difficult that have been attempted by relaxation, and the authors are to be congratulated on the successful conclusion of what must have been a formidable volume of arithmetic.

D. G. CHRISTOPHERSON

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* *Phil. Trans. Roy. Soc.*, A, **240**, 117 (1946). "Relaxation Methods Applied to Engineering Problems. XII. Fluid Motions Characterised by Free Stream-lines", by Dr. R. V. Southwell, F.R.S., and G. Vaisey.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, March 18

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. S. Herbert Frankel: "Whither South Africa?"

Society of Chemical Industry, Agriculture Group (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. L. Leyton and Mr. G. W. Dumbleby: "Soil Conditions and Tree Growth".*

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. E. B. Ford: "Recent Advances in Genetics".

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. John Read, F.R.S.: "Historic St. Andrews and its University".

Royal Anthropological Institute (joint meeting with the International African Institute, at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Mr. G. I. Jones: "The Aba Market and Ibo Distributive Trade".

Institute of Petroleum, Northern Branch (at the Engineers' Club, Albert Square, Manchester), at 6 p.m.—Dr. Whalley: "Progress on the Synthesis of Fuels and Lubricants".

Chemical Society, Nottingham Section (in the Large Chemistry Theatre, University College, Nottingham). at 7 p.m.—Dr. A. E. Alexander: "The Application of Surface Chemistry to Colloidal Problems" (Tilden Lecture).

Royal Institute of Chemistry, Manchester Section (at the Grand Hotel, Manchester), at 7 p.m.—Sir Henry Dale, O.M., F.R.S.: "Chemistry and Medicinal Treatment" (Dalton Lecture).

Society of Dyers and Colourists, Huddersfield Section (at Field's Café, Huddersfield), at 7.30 p.m.—Dr. F. Townend: "The Use of Acids in Wool Dyeing".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Welwyn Garden City Scientists' Club, at The Cherry Tree, Welwyn Garden City), at 8 p.m.—Dr. A. M. Ward: "The Training and Qualification of Chemists".

Wednesday, March 19

Physical Society (in the New Physics Lecture Theatre, The University, Manchester), at 10 a.m.—Conference on "Meteors, Comets and the Radio Detection of Meteors" (Fellows of the Royal Astronomical Society are invited).

Physical Society, Low-Temperature Group (at the Clarendon Laboratory, Parks Road, Oxford), at 12 noon–1 p.m.—Survey of the Work of the Low-Temperature Department of the Clarendon Laboratory; at 2 p.m.–3.45 p.m.—Short Talks on Selected Topics and Tour of the Laboratory.

British Society for International Bibliography (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Beginners' Questions on the Use of the Universal Decimal Classification Answered.

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the London Branch of the Institute of Physics, at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. K. Rideal, F.R.S.: "Monomolecular Layers".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting. Dr. A. E. Trueman, F.R.S.: "Stratigraphical Problems in the Coalfields of Great Britain" (Presidential Address).

Institution of Post Office Electrical Engineers (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E.C.4), at 5 p.m.—Mr. W. J. Ford: "A Review of Compressed Air Technique and its Practical Application".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Prof. Douglas Hay: "British Coal Mining and the Industrial Revolution, with special reference to the Life and Work of the late Lord Cadman" (Cadman Memorial Lecture).

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. F. Broadway, Dr. C. J. Milner, Mr. D. R. Petrie, Mr. W. J. Scott and Mr. G. P. Wright: "Velocity Modulation Valves".

Sir John Cass Technical Institute (at Jewry Street, Aldgate, London, E.C.3), at 6.15 p.m.—Dr. G. M. Dyson: "The Dyson System of Indexing Organic Compounds".

Society of Chemical Industry, Food Group (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Dr. W. G. Ogg: "A Survey of the Work of the Rothamsted Experimental Station" (members of the Agriculture Group are invited).

Society of Dyers and Colourists, Midlands Section (at the King's Head Hotel, Loughborough), at 7 p.m.—Dr. John H. Hill: "The Chemistry and Application of Detergents".

Thursday, March 20

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual General Meeting; at 3 p.m.—Prof. C. N. Hinshelwood, F.R.S.: Presidential Address.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. H. D. Megaw: "Temperature Changes in the Crystal Structure of Barium Titanium Oxide"; Mr. C. W. Bunn and Mr. E. V. Garner: "The Crystal Structure of Two Polyamides ('Nylons')".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Ostrowski: "The Different Types of Convergence in Formal and Numerical Analysis".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. A. W. Groves: "Results of Magnetometric Survey at Benallt Manganese Mine, Rhiw, Caernarvonshire"; Messrs. A. King, A. Clemes and H. E. Cross: "The Treatment of Gold Ore containing Pyrrhotite at the Sub Nigel, Ltd.".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. P. G. Wright: "The Modernization of the International Telephone Service and its Reaction on National Telephone Systems".

Institute of Fuel, North-Western Section (at Radiant House, Bold Street, Liverpool), at 6.30 p.m.—Mr. F. Aldred: "Water Treatment".

Chemical Society, Aberdeen Section (joint meeting with the Local Section of the Royal Institute of Chemistry, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: "Recent Developments in the Chemistry of Starch and Glycogen".

Royal Microscopical Society (joint meeting with the Electron Microscope Group of the Institute of Physics, in the Great Hall of B.M.A. House, Tavistock Square, London, W.C.1), at 7.30 p.m.—Mr. J. Smiles: "Survey of the Inter-relationship of Microscopical Techniques".*

Royal Society of Tropical Medicine and Hygiene (at the Royal Army Medical College, Millbank, London, S.W.1), at 8 p.m.—Laboratory Meeting, and Demonstrations.

Friday, March 21

Physical Society, Optical Group (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 3 p.m.—Mr. W. C. Hynd: "The Physical Properties of Glass"; Mr. T. H. Wang: "The Degree of Inhomogeneity of Optical Glass and some Aspects of its Bearing on Optical Performance".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Modern Methods of Time-Keeping" (to be opened by Sir Harold Spencer Jones, F.R.S.).*

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. M. E. Haine: "The Design and Construction of a New Electron Microscope".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "The Combination Torque-Converter and Fluid-Coupling Drive" (to be opened by Mr. B. J. Tams and Mr. A. L. Gatiss).

Society of Dyers and Colourists, Manchester Section (at the Gas Department Show-rooms, Manchester), at 6.30 p.m.—Mr. J. Henderson: "Temperature Range Properties of Vat Dyes on Rayon".

Society of Dyers and Colourists, Scottish Section (at St. Enoch Hotel, Glasgow), at 7 p.m.—Mr. J. R. F. Jackson: "Emulsions for Textiles".

Royal Microscopical Society (joint meeting with the Electron Microscope Group of the Institute of Physics, in the Great Hall of B.M.A. House, Tavistock Square, London, W.C.1), at 7.30 p.m.—Prof. W. T. Astbury, F.R.S.: "The Electron Microscope".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. D. Brunt, F.R.S.: "Where to Live—a Meteorological Problem".

Saturday, March 22

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. H. R. C. Pratt: "Purification and Azeotropic Dehydration of Acetonitrile".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Assistants (3) in Economics—The Registrar, The University, Manchester 13 (March 31).

Lecturer in Ancient Philosophy—The Secretary, The University, Edinburgh (March 31).

Head of the Department of Horticulture, and a Lecturer in the Biology Department, at the Essex Institute of Agriculture, Writtle—The Chief Education Officer, County Offices, Chelmsford (March 31).

Lecturer-in-Charge of the Chemistry Department, and a Lecturer-in-Charge of the Mechanical Engineering Department, in the Technical Education Branch of the Department of Public Instruction, Sydney—The Official Secretary, New South Wales Government Offices, 125 Strand, London, W.C.2 (March 31).

Robert Blair Fellowships (2) in Applied Science and Technology—The Education Officer (H.1/2), London County Council, County Hall, London, S.E.1 (April 1).

Lecturer in Physiology, and a Laboratory Superintendent, at Makerere College, Kampala, East Africa—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (April 1).

Lecturer in Chemistry and Soil Science at the College in Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (April 7).

Readership in Psychology tenable at the Institute of Education—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 24).

Entomologist with special interest in and knowledge of the Coleoptera, and an Entomologist with special interest in and knowledge of the Hymenoptera—The Director, Imperial Institute of Entomology, 41 Queen's Gate, London, S.W.7 (June 1).

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MINING POLICY IN BRITISH COLONIAL TERRITORIES

THE Secretary of State has issued a general directive to Colonial Governments, dealing with policy in mining and mineral exploitation*. The subject is clearly of much importance, and it cannot be too concisely or clearly set forth; discursive statements are not appropriate in a document of this character. The present memorandum contains matter that is trite and redundant, and it might have been better arranged.

The memorandum properly stresses that minerals are a wasting capital asset, and that the first step in mining policy must be the determination of the extent of such resources; for example, by geological surveys. This, of course, is a fundamental need; and the interest now being shown by the Colonial Office in the mineral field, and its recognition, as shown by the appointment of Dr. F. Dixey, formerly director of the Geological Survey of Nyasaland, as adviser to the Secretary of State in all geological matters, of the need for expert services, are encouraging. A reason why systematic survey has come rather late in the history of most territories is that individual mining enterprise has often been the first means of developing and settling regions which would otherwise have remained unattractive; the risks undertaken by private enterprise are rarely contemplated by a State Department.

Two paragraphs (5 and 6) contain strong pleas for the vesting of all mineral rights in the Crown. There are many good arguments in favour of this principle, which has, in fact, received general recognition for many years past, outside the British Isles; its main object being to provide some measure of control over the exploitation of natural resources for the general benefit of the community. This indeed is stated in the preface to the memorandum. One may cite as an example the acquisition of the mineral rights in Southern Rhodesia for the Dominion from the B.S.A. Company. (In parenthesis, it may be observed that bad early legislation gave rise to one of the worst mining law-suits in history within this territory.)

A good measure of indirect control can also be obtained by wise taxation; for example, on the Witwatersrand a sliding scale has been applied, by which the mining of low grade ores is encouraged, and the life of the field prolonged accordingly. In the paragraphs dealing with royalties and taxation (p. 8) it is observed that some such system is being considered for gold mining in Tanganyika and Fiji, in lieu of the standard rate of royalty usual in most Colonies, and may be extended to other forms of mining if practicable.

Since the whole problem of the relation of mining to the community has been the subject of intensive study in the Union of South Africa for many years, it is surprising that the question is only now under consideration for the Colonies. Conditions there do not much resemble those in Great Britain, and have no parallel in the British coalfields; but are more nearly aligned with those in the great mining Dominions. Is it too much to hope that the Colonial Office may look to their example and practice for guidance? In many of these, private enterprise has been the foundation of lasting prosperity and has much to be proud of. It should not lightly be subordinated to current political theory. One suspects, however, that the arguments favouring State control bear some direct relationship to the density of population. Sparsely populated and undeveloped territories are still very dependent upon the efforts of individuals toward their progress.

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* Memorandum on Colonial Mining Policy. (Colonial N.206.) Pp. 10. (London: H.M. Stationery Office, 1946.) 2*d*. net.

In advocating the ownership and operation of active mines by the State, the memorandum is on far less secure ground. Once a series of highly technical operations is subject to modification by political desiderata, its efficiency must fall. There is an ever-present risk of jobbery; the danger that a Government may only acquire well-developed or profitable properties; suppress legitimate ventures; or squander public funds unjustifiably. In the case of bodies set up by the State, there may be no general meetings at which shareholders and the Press are represented; and the staffs are not subject to the strict rules and discipline of the Civil Service. It is stated that "mining should be carried on according to a deliberately planned programme and its social consequences carefully foreseen and directed . . ." (par. 7). The fact is that, except in certain large well-explored and well-developed fields, mining is too much of an adventure into the unknown to permit of long-range forecasting. That is why, presumably, a policy of short-term leases is advocated (p. 6).

It is twice indicated in the memorandum that Governments should control the rate of exploitation of minerals. This statement requires amplification. The ultimate goal must be to recover the maximum possible quantity of an irreplaceable commodity at a reasonable expense. Nevertheless, it is wise to maintain a strategic reserve within any territory; so that the rate of production must adjust itself to the ascertained reserves, to the demand within the Colony, and the permissible rate of export or other mode of dispersal of minerals. Some form of subsidy for minerals in short supply or of low concentration may well be justified. Once mining has become established, it is subject to regulation by many imponderable factors, and the expert in charge must have the last word, whether the mine is privately or publicly operated. An artificial fluctuation of output or a premature shut-down may cause infinitely more mischief than controlling the production of a factory. It cannot be emphasized too strongly that adequate ore reserves should be developed by exploration before there is major expense on ancillary operations such as provision of plant, power, transport and water supply. The failure to observe this principle has often been one of the weaknesses of private enterprise.

The statement appearing on page 9 of the memorandum that "Governments should seriously consider public exploitation wherever practicable", notwithstanding the diverse conditions in the Colonies, may suffice as a direction to officers of the Crown; many others, however, will not be prepared to accept unchallenged a general statement of this character. Too much depends on the interpretation of the qualifying phrase "where practicable".

The question of mineral resources is now one of world importance; if distress and strife are to be avoided, some world-wide pool for the conservation, distribution and recovery of mineral products may well have to be established. But if, as the present memorandum indicates, minerals are "a gift of Nature to be shared", they are not won without hard planning, work and risk. A distinction must be made between legitimate wants and an importunate clamour for the fruits of someone else's labour. The consequences of mineral policy during the last two decades in the two great mining countries, Mexico and Brazil, where the doctrine of national ownership has been promulgated, might well repay closer study.

Much of the memorandum, however, concerns itself with matters that are normally dealt with by mining engineers or mining economists within individual territories; for example, by the Government Mining Engineer in South Africa, or the Bureau of Mines in Canada; and Colonial Governments must necessarily attach considerable weight to the opinions of their local expert advisers. A close liaison between them and the home authority is eminently to be desired; but too narrow a direction may well be out of place. Some recommendations in the memorandum could only be decided by an expert on the spot.

In securing expert services there is the urgent problem of providing suitable training for geologists and kindred workers in the various Colonial territories. Not all the British universities can provide teachers with the requisite Colonial experience, nor can the British Isles afford a wholly appropriate training ground. In this respect, Canada, Australia and South Africa are more fortunate; and recruits to the Colonial Geological Survey Services ought to be given facilities for special training and experience in the Dominions as well as in Britain.

X-RAY CRYSTALLOGRAPHY IN INDUSTRY

Radiocristallographie

Par André Guinier. Pp. ix+294+16 plates. (Paris: Libr. Dunod, 1945.) 725 francs.

DURING the last twenty years X-ray crystallography has found many industrial applications in France as elsewhere. The present volume is written for the industrial man of science who requires a broad knowledge of the applications of the subject.

The first chapter gives a short account of the properties of X-rays, the second chapter describes very briefly the types of X-ray tubes and high-tension equipment at present in use. The third chapter gives a summary of the theory of crystallography in so far as it is necessary for the determination of cell dimensions; but it is the author's expressed intention not to include a discussion of space-groups or of the methods of finding actual atomic arrangements within the unit cell. Chapter 4 gives an account of the principles of X-ray powder photography, and Chapter 5 discusses the taking and interpretation of rotating-crystal and of Laue photographs. The concepts of the reciprocal lattice and of the reflecting sphere are used; but the discussion of them is rather too brief to enable a serious student to understand the problems fully. The omission of moving-film photographs is surprising seeing how many applications they now have. One of the author's main contributions to recent developments in X-ray crystallography, namely, the use of the focusing monochromator, is described in Chapter 6. Though introduced originally by Johannsen in Sweden, the focusing monochromator has in recent years been more developed and applied in France than elsewhere. This book contains a number of the author's beautiful photographs taken with this monochromator; and for many purposes where freedom from background fogging is necessary, it is particularly valuable. Chapter 7 deals with the study of crystal texture, and includes both the determination of the size of small crystals and the preferred orientation of crystals in polycrystalline aggregates. This discussion also is rather brief, and the omission of the use of charts of constant θ-, ρ- and ω-values is unfortunate. The absence of references to moving-film methods of studying preferred orientation also restricts the usefulness of this chapter. Chapter 8 deals with the connexion between cell dimensions and chemical composition, particularly in relation to solid solution in alloys. A short section is devoted to the measurement of internal stresses in metals by the changes in cell dimensions induced by those stresses. Chapter 9, on superlattices, leads on to a more general study of imperfections in crystals in Chapter 10. This chapter includes the study of the influence of the size of crystals, of thermal agitation and of the effects of cold-working on the breadths and intensities of powder lines. Chapter 11 deals with diffraction by liquids and amorphous bodies. The twelfth and last chapter describes another special contribution of the author to this subject, namely, the use of the scattering of X-rays at very small angles from the incident beam to determine the shape and size of the particles. This method, which is applicable to aggregates of particles ranging in size between 20 and 500 A., no matter whether they are crystalline or amorphous, is likely to yield valuable information on colloidal substances which is complementary to that which can be obtained by other X-ray methods.

The nine appendixes deal with various proofs of fundamental theoretical relations and with a short account of the use of the stereographic projection. Among the tables there is one very useful table of spacings in relation to Bragg angles for cobalt $K\alpha$ radiation, which is not given in the "International Tables for Crystal Structure Determination". The sixteen plates contain some beautiful X-ray photographs which reveal the great advances made in technique by the use of strictly monochromatic radiation.

In conclusion, the author is to be congratulated on producing, just at the end of the War, and under the difficult conditions which then prevailed in France, a work which will be much appreciated not only in his own country but also in every country where X-ray crystallography is studied.

W. A. WOOSTER

THE COAST OF ENGLAND AND WALES

The Coast-line of England and Wales

By J. A. Steers. Pp. xix + 644 + 117 plates. (Cambridge: At the University Press, 1946.) 42*s*. net.

THE appearance of a large and well-illustrated volume dealing with the shore-line of England and Wales is a notable event. Several books have been written about parts of our coasts, but there has hitherto been no full-length study of the coast as a whole, and Mr. Steers is warmly to be congratulated on the completion of so extensive a task and on the successful publication of his work at this time.

Essentially, Mr. Steers' approach is that of the physiographer concerned with the factors influencing coastal forms, and he has included a chapter dealing with such general physiographical considerations as wave action and the movement of shore material, the orientation of beaches and the forms of cliffs. In the eight chapters dealing with particular sections of the coast he has emphasized these aspects of shore-line evolution, at the same time directing attention to the geological conditions which have largely controlled the development of major features both of coastal and inland areas. The close relationship between the nature of the coast-line and the previous history of the area of which it forms the present boundary is a constant theme. Thus much attention is given to changes of relative level of the sea, which have influenced the erosion both of the coast and adjoining land areas. A special chapter towards the close of the volume deals with these recent vertical movements of the shore-line, and present knowledge of their chronology is summarized: but the author well realizes the wide divergencies of opinion regarding problems such as the correlation of raised beaches in distant areas, and the reader is warned that final conclusions are not yet in sight.

The difficulty of a simple classification of our coasts is fully recognized, since in many areas a succession of emergences has been followed by a comparatively recent submergence. As the author points out, "it is clearly difficult to regard much of the Welsh coast as merely either submerged or emerged", and a similar statement would be justified in most parts of Britain. In some areas the results of submergence, and in others the results of emergence, are outstanding, owing to the previous contour of the land or adjacent sea bed.

In his survey of the coasts, as he himself notes, the author has given rather more space to the flat coasts than to cliffed coasts. In the former he finds that there is often an interesting physiographical evolution to trace, while in the latter it is hard to provide much more than a dull statement of rather obvious facts. He notes, however, that there seems "to be scope for a good deal of very interesting work on the intricate details of many miles of rock-bound coast", and suggests that the stratigraphical geologist working on a coastal area could often aid greatly in an understanding of the development of cliff forms. It may be suggested that the preparation of diagrammatic interpretations of the geological structure of the cliff (as in Fig. 102 in this book, showing a part of the Yorkshire coast, and Fig. 51 of Dorset) would enable many physiographers to appreciate very rapidly the essential factors in the structure and to see their relationships to cliff form. Indeed, it would have been a great help to many non-geological readers if such geological diagrams of the cliff face of various areas had been more freely introduced by the author, and it may perhaps be hoped that he will consider this when a new edition is called for. Details of cliff form are so closely related to geological structure that large-scale diagrams may be very illuminating. We may feel some sympathy with Mr. Steers in this matter, however, for notwithstanding the great variety of cliff profiles, caves and headlands, the description of numerous examples of the relationship of rock structure to cliff pattern, so easy of interpretation in most cases, is not a task in which many will find inspiration.

While the author discusses much detail of coast patterns, he has not neglected some of the wider features. Particularly interesting is his treatment of the more notable inlets, such as the Wash, the Thames estuary and the Bristol Channel. The origins of the two latter are compared, and although the surface geology of the two areas is very different, attention is called to suggestions that both are due to Miocene movements, possibly influenced by structures of earlier date. It may be noted that the boundary between Palæo-Europe and Meso-Europe extends approximately parallel to these depressions, and the Bristol Channel at least follows a belt which separated regions of different character both in early and later Palæozoic times; it may correspond to a belt of great tectonic significance. Several lines of evidence point to the occurrence of post-Jurassic (presumably mid-Tertiary) movements in the Bristol Channel area; among these the occurrence of sharply folded and thrust Lower Lias on the Channel shore of North Somerset is important, though its significance in this connexion has not been stressed. Prof. O. T. Jones produced a contour map of the base of the Lias in part of the area, showing marked folding which he suggested had resulted from Miocene movement. Mr. Steers correctly notes, however, that intra-Liassic folding may account for some at least of this folding (p. 191); moreover, later Jurassic movements (especially pre-Vesulian movements) in the Mendip area were such that the amount of Tertiary folding is not readily determined from the form of the Lias base. Mr. Steers also directs attention to the fact that the Bristol Channel consists of two parts, an east-west section which may be regarded as extending eastwards into the flats south of the Mendips; and a north-easterly section, the Severn estuary, the origin of which has not been fully explained, though it is related to the structural features.

It will be seen that Mr. Steers has written a book which is likely to stimulate geologists, physiographers and others to a livelier interest in coast features. He has taken a wide view, and has written much also of interest to the ecologist. Here and there he has introduced notes on coast protection and its problems, while he comments on many matters relating to the use of the coast-line and to its preservation. In short, this book should be consulted by many readers besides students of those subjects for whom it is written. If, as we may hope, many parts of our coasts are preserved for the benefit of those who wish to enjoy their beauties or to investigate the scientific problems they present, this book will provide information for those who are responsible for selecting the stretches of coast-line or for their maintenance.

It remains to add that there are two introductory notes, by Prof. L. Dudley Stamp and Sir Patrick Abercrombie; that there are numerous diagrams and maps (a few unfortunately without a scale—a real disadvantage for the reader); and that there are 115 photographs showing features from all parts of the coast, besides two very beautiful colour photographs.

A. E. TRUEMAN

NATIVE FARMERS AND BRITISH INDUSTRY

Colonial Agricultural Production

The Contribution made by Native Peasants and by Foreign Enterprise. By Sir Alan Pim. (Issued under the auspices of the Royal Institute of International Affairs.) Pp. ix + 190. (London, New York and Toronto: Oxford University Press, 1946.) 10*s*. 6*d*. net.

THE history of emigration and settlement contains little which our own or any other colonizing State can contemplate with much satisfaction, when considered in relation to the native populations of the countries colonized. For long years the natives were at best sources of cheap labour for the enterprises initiated by the colonists, and it would be no exaggeration to say that any consideration for them, any recognition of their organisations and social institutions, or any feeling of responsibility for the improvement of their economic condition, are things of very recent growth. The idea of trusteeship for backward peoples, always present in our best administrators, was not generally recognized by British public opinion until well into the present century. Even to-day, it could not be said that the interests of those controlling the capital invested in plantation agriculture are always pursued with due regard for the native communities upon whom they depend, almost exclusively, for manual labour. The importance of the Colonies, however, in our national economy is even greater to-day than it was before the great changes in the commercial structure of the British Empire and its relations with other countries brought about by the War. The problem is how to develop their great latent resources in the interests alike of the Empire and of the native populations, and this, in the main, is the problem with which Sir Alan Pim deals in his new book, which is published under the auspices of the Royal Institute of International Affairs.

No one is better qualified than he either to describe the conflict of interests, where such exists, and to pronounce judgment upon it, or to direct our attention to the great field of work still awaiting our administrators in the Crown Colonies, in raising both the social and the economic standards of life among the native races. Following a distinguished career in India, Sir Alan has been employed by the Government on special missions to Swaziland and Zanzibar, Bechuanaland, Basutoland, Kenya, Northern Rhodesia, among British African dependencies, and to British Honduras. Thus he had been able to study the problem over a wide range of territories and races, exhibiting every stage of development in agriculture, from the entirely primitive native production to the highly developed plantation industry, and every stage of culture from the untutored savage to the native graduate at a British university.

The results of his study are presented geographically in his recent book: the Netherlands Indies, Malaya, Ceylon and Mauritius; Fiji and the West Indies; the tropical African dependencies; and British Central and East African dependencies. Sir Alan quotes Lord Hailey for the statement that "it has been an outstanding tenet of British Colonial policy that peasant production is to be preferred to any of those forms of development involving the use of imported capital and management, which are generally known as the 'plantation system'". It would be interesting to know when this became the official policy, for there is little in the organisation, for example, of so young a colony as Kenya, to suggest that the Home Government had been seriously concerned, from the first, to promote the agricultural development of the natives. However, this is only one issue; and not the least interesting feature of Sir Alan's book is his description of the great variety of social and economic conditions with which the administrations have to contend. Not only is there the question of getting a 'square deal' for the natives under the plantation system, there is also the difficult problem of improving the technique of great numbers of native producers who are misusing the land or failing to use it fully, to the detriment in either case of their standards of life; and lastly there is perhaps the most important consideration of all, how can the native standard of farming be raised in association with the production of a market crop?

Native producers the world over are mainly subsistence farmers, and only by the evolution of a land utilization system which can combine self-supply with steady production for the market will it be possible to introduce or to extend a cash economy, in the interests alike of the native countries and of the highly organised States such as Britain, who have assumed responsibility for their administration. The self-sufficient peasant or native farmer has a strength that no other class of any community can show, for he need never starve. At the same time, his standard of life is generally a low one, often falling below an adequate nutritional level, and the only escape is by the practice of some form of husbandry which will enable him to enter the market with something to sell. Immediately, he becomes a purchaser of other requisites than food, or of foods with which to supplement the deficiencies of his own culture, and there is a general rise in the economic level of the community.

How to bring about these conditions would seem to be the principal aim of British Colonial administration. It involves education, finance, health services, and public works of all kinds for opening up the territories. Sir Alan writes with authority on all these subjects, and on the special difficulties which have to be faced in each of the countries reviewed—problems of land tenure, for example, or of credit, or of training for the labourer, particularly in the use of labour-saving appliances and machinery. In some countries, physical and climatic conditions call for heavy expenditure on capital works such as irrigation, if agricultural production is to be possible. In other countries, the populations are so sparse that labour may have to be imported; in others again, too densely populated, the subdivision of land has gone too far for good living, and the organisation of other industries for alternative employment is pressing. At the present time, much is to be hoped, and may even be expected, from the development of native agriculture, alike in the interests of the agriculturists and of British trade and industry.

C. S. Orwin

SCIENCE AND THE HISTORY OF SOCIETY

The Path of Science

By Dr. C. E. Kenneth Mees, with the co-operation of Dr. John R. Baker. Pp. xii+250. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1946.) 3 dollars.

In this book the author has expanded a course of lectures on the development of science and its relation to the history of society, recently given by him as Hitchcock professor at the University of California. The first of its ten chapters deals with the interpretation of history, and the different conceptions that have been put forward, namely, unique events, cycles of civilization, and the idea of progress. Dr. Kenneth Mees rightly directs attention to the separation of humanistic learning from scientific knowledge, and adds: "The humanists must understand what the scientists have done in the past, are doing now, and may do in the future; while the scientists must see their work in the light of history and in relation to the effects that its application to social conditions will produce".

The second chapter is an attempt to reconcile the various conceptions of history. The theme is the 'Helix of History', which admits of a vertical component as well as indicating the idea of revolutions of civilization. The frontispiece shows how the helix may steadily increase the separation of its coils, and then, suddenly, after the discovery of the methods of experimental science, spring upward in an almost vertical direction.

Chapters 3 and 4 deal with the method of science and its development. Reference is also made to the sense of 'frustration' felt by such writers as Prof. J. D. Bernal, and it is pointed out that it is not organisation that will solve the difficulty, but more knowledge. With regard to the latter, it is "quite impossible to predict in advance whether any particular scheme of scientific work will produce results which can be 'applied'". Explanations are reviewed of the unique phenomena of the seventeenth century, and reference made to the comparatively small number of those responsible for scientific development since that period.

About one third of the book is devoted to a comprehensive survey of the growth of the major sciences—physics, chemistry and biology. In the words of the author, this forms a "résumé of the ideas of science and the methods by which these ideas have been evolved. A brief account of science intended to give a picture of the whole to an educated man." The growth of physical and chemical ideas is traced by Dr. Kenneth Mees, and indicates a wide interest of subject, culminating in atomic fission and the cyclotron. Chapter 7, "The Growth of Biological Ideas", is written by Dr. John R. Baker, lecturer in zoology in the University of Oxford, who with a wealth of knowledge and experience traces the development of modern biology from 1537, the year in which Vesalius settled in the University of Padua. Reference is made to individual work, as well as to broad lines of development. The chapter concludes with a plea that physiology should break loose from subservience to medicine; then "we may look for rapid progress in our understanding of the processes of growth and differentiation".

The remainder of the book deals chiefly with the organisation of research—whether for basic scientific knowledge, or in the more applied form of industrial research; and Dr. Kenneth Mees' experience—he is vice-president in charge of research, Eastman Kodak Company, Rochester, New York—gives weight to his analysis of the problem. The book concludes with a short chapter in which the "Path of Science" is reviewed, particularly with reference to methods of government and political leadership.

H. D. Anthony

TEACHING OF INORGANIC CHEMISTRY

General and Inorganic Chemistry

For University Students. By Prof. J. R. Partington. Pp. xxiii + 916. (London: Macmillan and Co., Ltd., 1946.) 36*s*.

HOWEVER much a new text-book from an authoritative writer may be welcomed, an even warmer reception usually awaits a well-established text after searching revision. Prof. Partington's "Text-Book of Inorganic Chemistry for University Students" is familiar to every student of chemistry, and an up-to-date text-book, planned in a generally similar way and from the same pen, is a valuable addition to our teaching resources. The new "Partington" is a distinct advance on its predecessor, particularly in the provision of much-expanded sections on the chemistry of the less common elements.

The book is divided into two distinct sections. The first, comprising rather less than one third of the text, is an outline of classical physical chemistry, at a standard adequate to provide for intermediate and university scholarship candidates. The second section treats the chemical elements in the order of groups in the 'short' Periodic Table; this section is of substantially higher standard than the first, and it is designed as a basis for work up to general degree level in inorganic chemistry, the intention being that honours students should read the more advanced aspects of the subject in original papers and specialized texts. The book thus provides all the physical and inorganic chemistry needed by a university scholarship candidate, with sufficient additional material in inorganic chemistry to make it useful right up to the honours degree examination. The policy of covering so much ground in a single volume is perhaps open to question, but Prof. Partington's succinct style of writing and careful selection of material have ensured thorough treatment of the whole field, and consequently a wide appeal for his book.

The general and physical chemistry section of the book is well planned on conventional lines, and proper attention is given to atomic and molecular weights, the kinetic theory, the phase rule, solutions, thermochemistry, electrochemistry, and chemical and electrochemical equilibria. Four chapters at the end cover the Periodic Law, modern atomic theory, the solid state, and the quantum theory of the atom and of valency; these chapters provide a basis of general principles for the inorganic section of the book. Unfortunately the pace of recent developments and war-time restrictions have been such that the treatment of radioactivity will need considerable expansion at an early date. The discussion of valency affords a useful picture of modern views without being too highly theoretical, and is well adapted to students' needs. The sections on the structure of solids, however, are disappointing, and do not sufficiently reflect the basic importance of structural concepts in the inorganic chemistry of solids. Non-stoichiometric relationships in solids, particularly, merit more consideration in view of the rapidly growing appreciation of their fundamental significance.

The inorganic section of the book, considered as a concise and accurate presentation of chemical facts, is uniformly excellent, and the author is to be congratulated on covering a large and diverse field of knowledge in a way that is open to little detailed criticism. However that may be, the general approach to the subject as a whole is unattractive; in its condensed and rather uninspiring presentation of factual chemistry, the book may tend rather to weaken than to arouse interest in the inorganic field. Admittedly there is no short cut to a knowledge of the descriptive chemistry of the elements, and for this reason the adoption of a simple system of treatment based on the Periodic Table merits hearty commendation; too early an attempt to systematize the facts of inorganic chemistry leads to disillusionment when the exceptions are discovered to be far too numerous to prove the rules. Nevertheless, many branches of modern inorganic chemistry lend themselves to discussion in such a way that broad lines of progress are emphasized, and genuine interest promoted in the reader. The present work retains the classical style of inorganic text-books rather too tenaciously.

Prof. Partington maintains in his preface that students should consult original papers in the course of their studies, and he gives a century-old quotation by George Fownes in support of his view. During the past century, however, inorganic chemistry has developed rapidly, particularly in the application of new experimental techniques, and university courses have also changed a good deal. Modern students complain, not without good reason, that they are expected to read far too much; they will scarcely welcome the author's suggestion that his admittedly concentrated survey is intended as a companion to more or less extensive reading elsewhere. They will find it a hard task, in fact, to use the book in this way. The references are too numerous and insufficiently discriminating, and unless they are followed up with a measure of wisdom uncommon in students they will lead to a detailed knowledge of a few selected topics, at the expense of a broad general acquaintance with inorganic chemistry. Certainly a graduate in chemistry should have studied original memoirs of recognized merit; but their selection requires much more definite guidance than this book affords. In inorganic chemistry, original papers are best used in the study of special experimental methods and their application, which usually possess sufficient inherent interest to hold the reader's attention and infuse in him something of the spirit in which the science has developed.

Prof. Partington's book deserves popularity, but its limitations should be realized and counteracted by wise counsel from the teacher—an indispensable adjunct, after all, to any university course. If the book arouses interest in the whole subject of teaching methods in inorganic chemistry, Prof. Partington's service to chemists, already great, will be yet greater.

Adequate descriptions of lecture experiments are given throughout the book. The diagrams are clear and well chosen, and the standard of printing and production is high.

A. J. E. Welch

THE INDIAN SCIENCE CONGRESS

DELHI MEETING

By SIR CHARLES DARWIN, K.B.E., F.R.S.

THE thirty-fourth Indian Science Congress was held at Delhi between January 1 and January 8, and was attended by delegations from various countries. From Great Britain delegations were appointed by both the Royal Society and the British Association, and it is appropriate to recall that nine years ago the British Association had sent a large party to the twenty-fifth Congress, when it met in Calcutta. I had the privilege to be a member of that earlier party, and it was pleasant to renew acquaintance with Indian friends, and interesting to witness the progress in science made in the interval. The other delegations were from Canada, the United States, France, the U.S.S.R. and China, and we were all treated in a most generous manner by our hosts, who bore all the expenses of our stay in India, arranged for our tours to all parts, and looked after us most considerately the whole time.

As to the personalities of the Congress, the president was Pandit Nehru, who managed to spare a very considerable amount of time from his other activities, both in attending the meetings and in entertaining the visitors; it is encouraging to see what a large place the furtherance of scientific development plays in the plans of the political leaders. The chief part in organisation was played by Sir Shanti Bhatnagar, who occupies in the Government of India a position akin to that of the secretary of the Department of Scientific and Industrial Research in Great Britain. It is largely due to him that India is establishing no less than five new government-controlled research institutions, one of them in physics, but of this more below [see *Nature*, February 8, 15 and March 1]. The secretaries were Prof. P. C. Mahalanobis, the statistician, and Prof. D. S. Kothari, the physicist. In addition to the others who assisted in the organisation, special mention should be made of a large body of 'volunteers', students of the University of Delhi, who seemed to be able always to give the right kind of help, whether in setting up a lantern, re-arranging chairs, taking messages, or clearing gangways, without, so far as one could see, any instructions at all.

Apart from the Russians, who of course came by a different route, most of the delegates flew together from London to Delhi, and slightly disorganised the Congress by arriving late on account of the weather at the start. Consequently the opening ceremony was postponed a day. It was held in the grounds of the University of Delhi, and there was a very large attendance, including many prominent members of the Government of India. In addition to the presidential address, there was an address of welcome by Sir Maurice Gwyer, the vice-chancellor of the University, and other speeches were made and letters of goodwill presented, including one from Sir Henry Dale as president of the British Association.

On the following day there was the ceremony of laying the foundation stone of the new National Physical Laboratory by Pandit Nehru. This is to be built on a large vacant site not far from New Delhi, and near the already existing Agricultural Research Institute. It was a great pleasure to me personally to witness this scene since, when Sir Shanti Bhatnagar led a mission to Great Britain a year ago, he had told us much about his plans for a laboratory to parallel our own N.P.L. In a country like India, where industrial development is rather young, there is great need for a centre which can look after standardization, and this will probably be the main activity of the new Laboratory at the start, though it very properly intends to undertake a good programme of research as well. On another day we attended a ceremony when the foundation stone was laid of an Institute of Industrial Research, which is to be an organisation on something of the lines of the Mellon Institute in Pittsburg. It has been established through the generosity of Sir Shri Ram as an independent institution, and lies in grounds next the University. Yet another ceremony we attended was the conferment by the University of Delhi of honorary degrees. Lord Wavell, who is chancellor, made a great impression by speaking in Russian when he conferred degrees on the Russian delegates.

With these engagements and with much hospitality given to us, it was not easy for the visitors to attend the sectional meetings with any diligence. Each evening some of us gave lectures on general scientific subjects to audiences of something like two thousand, and we were much struck by the interest and enthusiasm of these audiences, and the notable absence of the restlessness which would be expected among such a large number. Most of us also gave papers in the sections, but it was not possible to attend the meetings regularly, and for the rest it is only possible to record general impressions. Of mathematical studies the most flourishing is statistics; including theory and application, there were no less than fifty-three contributions on the subject. Of the distinction of the many workers in physics it is scarcely necessary to speak, though reference should be made to the newly established institute in Bombay under the direction of Prof. H. J. Bhabha. In experimental physics it is refreshing to see what a lot of important work can still be done outside the nucleus. Some of us have felt there was a danger that all interest had disappeared in general physics, even including in the term the atomic physics which flourished fifteen years ago, and it is reassuring to see such a good list of titles in the subject, leaving no doubt of what a lot of interesting work there still is in it. Of other subjects I cannot claim personal knowledge, but from colleagues I have gathered that in the biological sciences the emphasis has been more on the systematic and taxonomic side, rather than on the physiological. This is perhaps natural and proper, since the fauna and flora of India must still repay closer study than they do in an intensely explored region like Europe. On the side of practical developments in scientific agriculture the outlook is most promising, though in that field there is the opposition of the intensely conservative traditions of peasant agriculture.

During the week of the Congress there was an Exhibition of Scientific Instruments in the buildings of the University of Delhi. Part of this was contributed by the Army, which showed much [illegible] the equipment it had developed for tropical warfare. One aspect shown was the damage done to military stores by various pests, both fungi and insects, and the methods of coping with it. The damage was enormous in quantity; for example, the termite is usually regarded as one of the chief tropical pests, but its damage did not rank very high in the list compared to certain beetles. There was an exhibition by the Meteorological Office of instruments and also of its methods of giving warning of flood or storm.

The chief items, however, were the manufacturers' exhibition of instruments. Before the War, scarcely any scientific instruments were made in India, but now quite a large number of firms are making them. There was a considerable variety of laboratory equipment, most of it the ordinary equipment suitable for students' laboratories. For a start this is clearly appropriate, since the demand for it is so large; but to judge by the workmanship it will not be long before more ambitious plans are made.

At the end of the Congress the visitors were taken by air to Agra for a day of sightseeing of the Taj Mahal and the other wonderful monuments near by. After this they dispersed all over India, especially to Calcutta, Bombay, Hyderabad, Bangalore and Lahore, to visit scientific institutions or to give lectures, and they then returned home separately. Since on my previous visit I had not seen the Punjab, I this time visited Lahore, which is the headquarters of the very large University of the Punjab, with its colleges spread over various parts of the province. Here I also had the good fortune to see something of the works of irrigation, including the hydraulic laboratory at Lahore and a field laboratory for hydraulic models at Madhopur, a hundred miles away. The development of hydraulics, both in experiment and practice, has in India reached a level beyond what we have yet achieved in Britain, as is witnessed not only by these laboratories but also by the actual irrigation works. In flying through Sind one goes over literally hundreds of square miles of intensively cultivated country now watered by the Indus which thirty years ago was a complete desert. In the Punjab the irrigation has been going on much longer, and they are now preoccupied with its less encouraging sides, the increasing salinity of the soil and the waterlogging.

From Lahore I went to Peshawar to see the north-west frontier. Though strictly speaking it is a digression from the subject of this article, one item of my visit may be mentioned, which is of metrological (or perhaps anthropological?) interest. Not far from Peshawar there is tribal territory which is not under the direct control of the Government of India. Here the blood-feud prevails and has called into existence a flourishing industry of rifle manufacture. The factory I saw must have had sixty or seventy workmen working with hand-driven lathes and hand-blown furnaces making rifles and revolvers which are exact copies of the British army types. They are expected to be so exact that they must be stamped with the appropriate marks, "V.R.", "Enfield", etc. The shaping is also accurate; for example, the block of metal for the chamber is filed by hand to match a template, though I confess it seemed to me that the match was visibly not quite perfect. The gun-sight was very accurately aligned with the barrel, but I could not find out how this was done. They showed me how the bore was measured during the work in a very simple manner, by pushing a conical bullet in at the muzzle so that the distance it went in gave an accurate indication of the diameter. Even the screws in the stock were hand made, but with the help of a set of taps acquired from England. The chief fault of the rifles, I was told, was that the heat treatment of the barrel could not be controlled, so that the life of the rifle was rather short; but since ammunition is hard to come by this is not so serious. I was told that it takes a man about a month to make a rifle.

For purpose of record it may be of interest to give a list of the various visiting delegations:

Britain. Prof. P. M. S. Blackett, Prof. W. Brown, Sir Charles Darwin, Sir Arthur Fleming, Prof. Munro Fox, Sir Harold Spencer Jones, Prof. L. J. Mordell, Prof. Dudley Stamp, Sir D'Arcy Thompson.

Canada. Dr. W. F. Hanna, Dr. T. L. Tanton, Prof. R. B. Thomson.

China. Prof. S. S. Chen.

France. Prof. and Mme. J. S. Hadamard.

U.S.A. Dr. A. F. Blakeslee, Dr. W. E. Deming, Dr. E. Newton Harvey, Dr. O. Riddle, Dr. Harlow Shapley.

U.S.S.R. Prof. Bolshaikov, Prof. E. N. Pavlovsky, Prof. S. Umarov, Prof. V. P. Volgin.

STRUCTURE OF CLAY

By Prof. NILS HAST
Kungl. Tekniska Högskolan, Stockholm

Methods of Investigation

Electron-microscopical studies on clays are generally performed by suspending the clay particles in water and transferring them to the specimen film in the microscope. By this means, however, it is impossible to gain insight into the structure of the clay, since this is broken down in the suspension process.

In studying the structure of clay, I have worked out and used the experimental procedure described below. The electron microscope used is that of the Nobel Institute for Physics, Frescati, Stockholm, at which Institute the investigations are at present in progress.

A fresh fracture surface is prepared in the clay by breaking a small piece of the material in a direction perpendicular, or parallel, to the natural direction of stratification. On this surface are spread immediately some drops of a liquid with a surface tension lower than that of water, for example, amyl acetate. This liquid then covers the moist surface of the clay, entering even the slightest irregularities. If, for example, cellulose nitrate has been dissolved in the amyl acetate, the evaporation of the solvent will leave a thin film of cellulose nitrate on the clay surface. This skin, which constitutes in some measure a cast of the surface, can afterwards be peeled off.

The molecular dimensions of cellulose derivatives, polystyrene and other suitable casting preparations are, however, so large in relation to the fine structure of the clay that a cast of the finest details cannot be made with their aid. As will be shown below, the structure of clay contains details measuring 15 A. or less, which is less than the molecules in the casting material. It is also known with respect to films of the materials mentioned that they possess structures of their own, which may render the interpretation of the photographs more difficult when very high magnifications of about 100,000 must be employed, as in the case of clay.

The present procedure is based on the idea that the projecting irregularities of the clay surface are surrounded with the 'casting material' and accompany the latter when it is peeled off, but that at other parts of the fracture surface also there is a certain adhesion between the cast and the clay. When the film is removed, a fracture may take place in the actual boundary layer, for example, if water

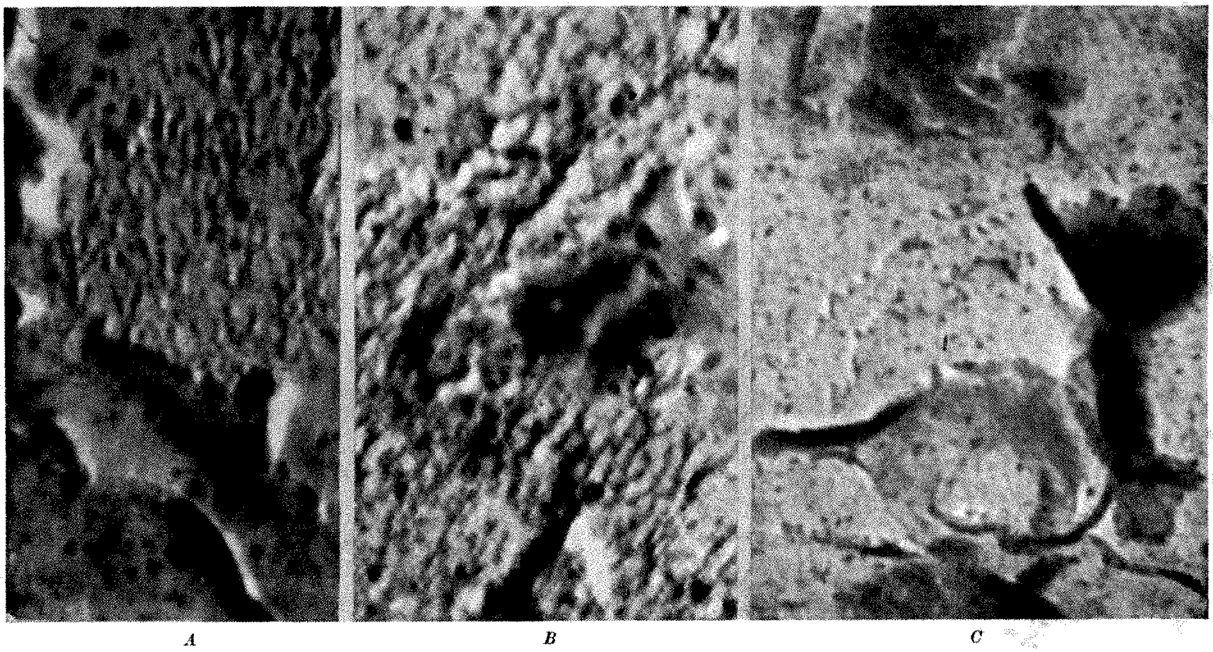
A B C

Fig. 1. BENTONITE, FROM KINNEKULLE, SWEDEN (UPPERMOST LAYER BUT ONE IN THE CHASMAPS SERIES)

A. Section perpendicular to the direction of stratification. In the fracture surface pile-like formations appear with a diameter of about 120 A. Some of them appear to have been broken during the preparation of the specimen. Both in the piles and in other parts shown in the photograph there can be observed a distinct lined structure parallel with the natural direction of stratification in the material. The photograph also shows the tendency of the material to split up into layers. × 70,000

B. Preparation as in Fig. 1. The piles and stratum structure are plainly visible. On the right of the photograph slight indications are seen of the piles in the 'scales'. × 64,000

C. The turning up of the outer parts of the split-up thin flat pieces ('scales') are clearly visible, causing a very pronounced absorption of the electron radiation. The apparently round crystals of which the montmorillonite seems to be built up can be seen lying flat on the surface. The object film prepared according to Method 1 gives excellent diffraction patterns indicating that the bentonite used consists of fairly pure montmorillonite

covers the surface of the clay ; but the fracture will often be situated somewhat within the clay in a region where the cohesion in the structure is at its minimum. The layer of clay removed in this manner will in some places be so thin as to permit direct observation of the structure undestroyed, provided that the supporting film is sufficiently transparent. The film must be fairly thick, however, in order to be peeled off, and will consequently be opaque. This film is used to fix the thin layer of clay, so that the structure of the clay will not be deformed during the subsequent preparation. The following technique is employed to make possible the desired observations of the clay structure.

The peeled-off film of cellulose nitrate with the accompanying particles and thin surface-layer of clay are introduced into a vacuum and coated with a very thin deposit of vaporized beryllium or aluminium 25–50 A. thick. The cellulose nitrate is then dissolved away with the aid of amyl acetate.

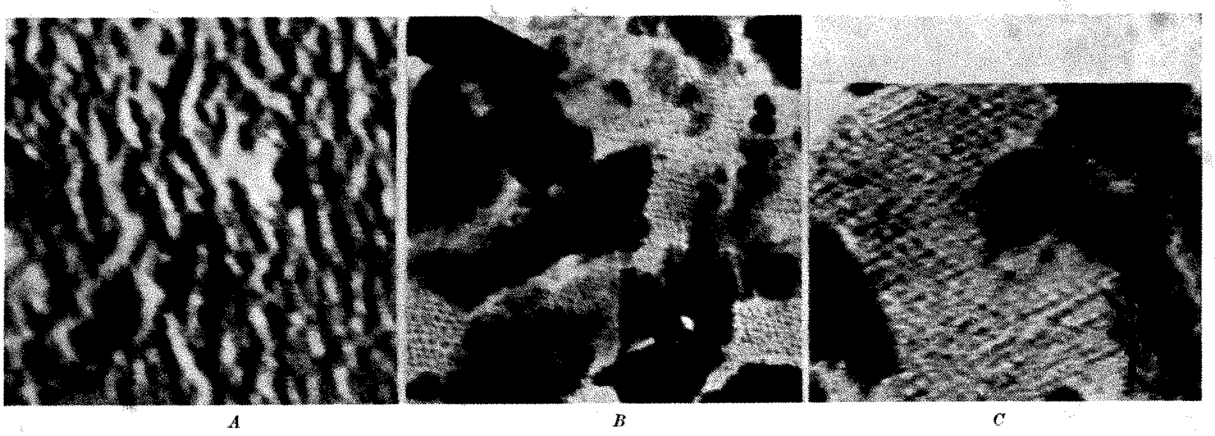
A B C

Fig. 2. CLAY, FROM VASBY, SWEDEN

A. A lined structure is clearly visible. The dark lines represent stratification layers, as a rule two or three atomic layers in thickness. They are separated by lighter lines—actually holes produced by layers having been withdrawn in the preparation process and accompanying the other fracture side. In the photograph are also seen dark piles, and between them are holes left by withdrawn piles, leaving, however, as has been mentioned, some layers unbroken which appear as the lined structure in the picture. × 70,000.

B. Fracture configuration of a thin layer of clay. Two axes can be discerned at an angle of about 60° to each other and lying symmetrically in relation to the direction of stratification, also seen in the photograph. × 53,000.

C. Fracture surface similar to that in *B*. × 83,000.

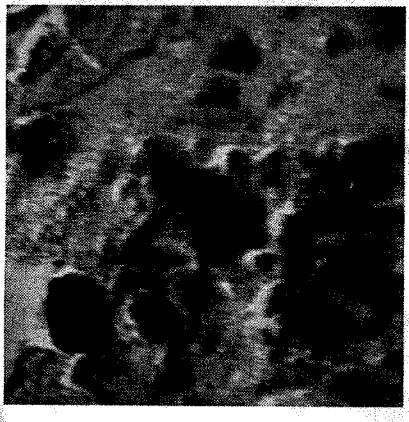

Fig. 3. CLAY. Section perpendicular to the direction of stratification. The holes left by the withdrawn single crystals are clearly visible. The width of the holes is about 120 A., but may also be double that or more. The depth of the holes corresponds to one or more atomic layers with the water layers between. Clearly marked lines with a thickness of less than 15 A. have been measured on the exposed plate. × 60,000

The removed layer of clay will remain adhering to the liberated metal film. The dissolution of the 'casting material' from the sample should preferably be carried out when the sample is placed on a specimen holder designed for direct introduction into the electron microscope for observation.

If the surface of the clay (or of any other material under investigation) has a fibrous or a porous structure, the solution of cellulose nitrate, or any other suitable solution being used, will penetrate to some depth. When the preparation is made in the way mentioned, a threadlike surface structure may be observed in the electron microscope with the threads in unaltered positions, precisely as if an extremely thin layer of the material had been cut off and transferred to the specimen holder.

As the deposited metal obviously cannot be of the same thickness at all points, one might have reason to fear that this would cause distortions in the photographs. This, however, does not appear to be the case if the film is very thin. (A photograph has been taken of a clay specimen, the thickness of the metal film being 25 A. Afterwards another 25 A. of aluminium was evaporated on the other side of the particles of the specimen and again the same part of the specimen was photographed. No details which were not visible before could be detected.) Even minute details in the clay structure prove to offer greater resistance to the electron radiation than does a beryllium or aluminium film of the minimal thickness in question. If, on the other hand, metals heavier than beryllium (or aluminium) are deposited, or if the beryllium (or aluminium) films employed are not exceedingly thin, the photographs will be distorted, and the finest details of the clay structure can no longer be detected.

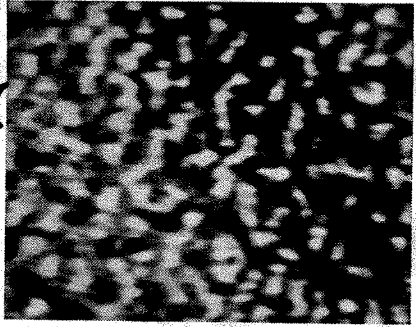

Fig. 4. FROZEN CLAY, from Väsby. The structure is in three dimensions. × 40,000

The clay surfaces have not been prepared with cutting tools, for fear that the surface structure would thus be destroyed or that water from internal cavities in the clay would spread over the surfaces. Even in the present method of breaking the clay, the coarse structure is somewhat deformed. In order to avoid this, experiments were made in which the clay samples were frozen before breaking. The frozen water stabilized the clay structure while the sample was broken off, and the structure appeared in a less deformed state in the pictures.

Other Casting Materials and Methods

In addition to cellulose nitrate as a base for the deposition (Method 1), other casting materials have been employed, largely with the aim of checking that the structure of the withdrawn film, dissolved away after the deposition of metal, does not appear in the final sample. With polystyrene, for example, the same picture of the clay and bentonite structure has been obtained as with cellulose nitrate.

Mention may also be made of the following method, intended to facilitate the reproduction of the clay structure without risk of including the structure of the casting material itself (Method 2). The film of cellulose nitrate, etc., withdrawn from the clay surface is laid, with the clay particles downwards, upon a very thin metal film (20–50 A.) on a specimen holder. The cellulose acetate is dissolved away with great care, for example, with amyl acetate. The surface layer of clay then lies on the specimen film. It is possible to do this in a satisfactory manner only if a drop of liquid is placed between the object film and the particle side of the cellulose nitrate film, the drop being evaporated before the procedure of dissolving begins. If the object film is very transparent, even the finest details in the clay structure may be observed directly. The procedure employed in preparing such extremely thin specimen films with low absorption will be described elsewhere (see p. 370 of this issue of *Nature*).

Structure of Clay

The composition of clay varies greatly according to the site of its occurrence. It usually contains substances belonging to the kaolinite and montmorillonite groups in addition to mica-like materials. As montmorillonite is identical in chemical composition with the mineral bentonite, the structure of the latter has been studied in parallel with that of clay by Methods 1 and 2. It has been found that the structure of bentonite observed in this manner is also found in a certain part of the clay material, apparently montmorillonite, which surrounds and binds together the other crystalline particles in the clay.

Photographs of bentonite and clay which I have examined seem to point to the conclusion that the montmorillonite is entirely built up of small, plane crystals—apparently round 'plates' about 120 A. in diameter. It seems likely that the plates are in fact hexagonal, though too small to be studied in detail. Their thickness seems actually to tally with that found by Hofmann and other investigators with the aid of X-rays (about 10 A.). The plates are

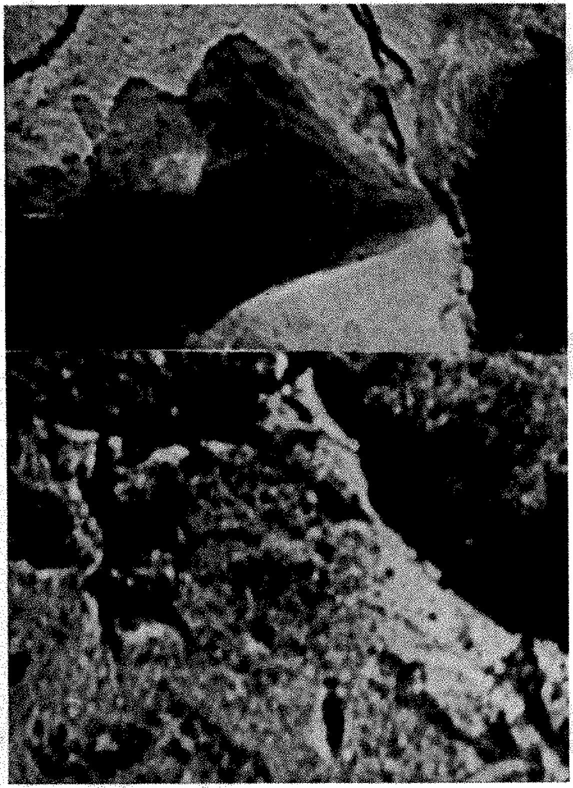

Fig. 5. MONTMORILLONITE. The layer is so thin that the structure system is visible, though in three dimensions. Upper picture, × 80,000; lower picture, × 40,000

placed one upon the other, but with a slight displacement of each in relation to the one beneath it, in a manner similar to that observed in kaolinite, and form piles, sometimes resembling threads. In a fracture of montmorillonite perpendicular to the natural stratification, these piles appear raised. Sometimes, especially when the layer of the clay removed is very thin (Method 1), figures of a regular form are to be seen in the fracture, indicating that the small crystals or plates may have regular positions in the direction of stratification. In this case it is possible that the plates are arranged in hexagonal nets, often not regular, as may be seen in some photographs, forming channels or cavities in the montmorillonite. The above-mentioned piles of plates, showing slight undulations, constitute the walls of these cavities.

The peeled-off thin layer of clay, bentonite, etc. (Method 1), has been produced on fractures perpendicular to, as well as on fractures parallel to, the natural direction of stratification.

If the montmorillonite is built up in the way suggested, that is to say, of piles of crystals with a comparatively slight force of adhesion between them, it will split into thin, flat pieces, somewhat like scales, whenever the preparation is made (Method 1) on a fracture perpendicular to that of stratification. The *C*-axis of the small crystals will then be parallel to the plane of the photograph. If the 'scales' are thin enough, the piles will be fairly clearly visible. Sometimes the 'scales' do not remain plane, their outer parts turning up and showing a very marked propensity to absorb electrons, but this effect may also depend on a variation in the thickness of the scales. In this particular the aspect is very similar to that observed when bentonite is suspended in water.

In the preparation of the clay surface and the removal of the cellulose acetate film, some of the 'plates' in the piles would appear to accompany one side of the fracture and some the other. The consequence is that line structures appear in the casts, these being holes left by withdrawn 'plates'. The thickness of the lines generally shows that they must represent two or more atomic layers together with the water-layers lying between. Occasionally, however, lines are observed that cannot be estimated as exceeding 15 A. in thickness. These suggest the cavities left by single atomic layers, with their attendant water-layers, withdrawn from the pile. That such narrow lines can be observed with such sharpness is due to the fact that the objects reproduced are layers seen edgewise, or cavities between such layers, with a depth of absorption some ten times greater than the width of the lines. The method should be capable of further development as a means of determining the resolving power of the electron microscope.

ATMOSPHERIC OSCILLATIONS*

THE theory of the tides is one of the many offshoots of Newton's theories of mechanics and of gravitation. Much of the later development of these theories was achieved by the great French school of mathematicians, and the first important steps in the theory of the atmospheric tides were made by Laplace (1774) and later described in his "Mécanique Céleste". He also was the first to attempt to determine the lunar atmospheric tide from barometric observations; he realized that tropical data were the most suitable for the purpose, but lacking them, he used 4,752 readings at Brest. His result, as he recognized, did not give the true tidal pressure variation at Brest, which is too small to be separated, in such a short series of data, from the solar daily variations and the much larger irregular changes associated with the weather.

The Lunar Atmospheric Tide

The lunar atmospheric tide was first determined in 1842 by Lefroy from bihourly barometric readings over seventeen months at the British Colonial Magnetic and Meteorological Observatory at St. Helena (16° S.). Smythe, Sabine and Elliot extended the analysis at St. Helena, and also determined the tide at Singapore. Several of the gifted directors of the Netherlands Government Observatory at Batavia (6° S.) made valuable determinations there, as their barometric data accumulated.

These successes were possible because in the tropics the lunar atmospheric tide has its greatest amplitude, while the irregular variations there are less than elsewhere (except during extreme cyclonic conditions). Further attempts to determine the tide in temperate latitudes by Bouvard, Eisenlohr, Neumayer, Airy (using twenty years hourly observations at Greenwich), Börnstein, Morano and others proved unsuccessful, until 1918, when Chapman made a determination for Greenwich, where observations covering sixty-

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* This article summarizes a Geophysical Discussion held at the Royal Astronomical Society on January 24, under the chairmanship of Sir Edward Appleton. The Discussion, which was opened by Prof. Sydney Chapman, was continued by Sir Geoffrey Taylor, Dr. M. V. Wilkes and Mr. K. Weekes.

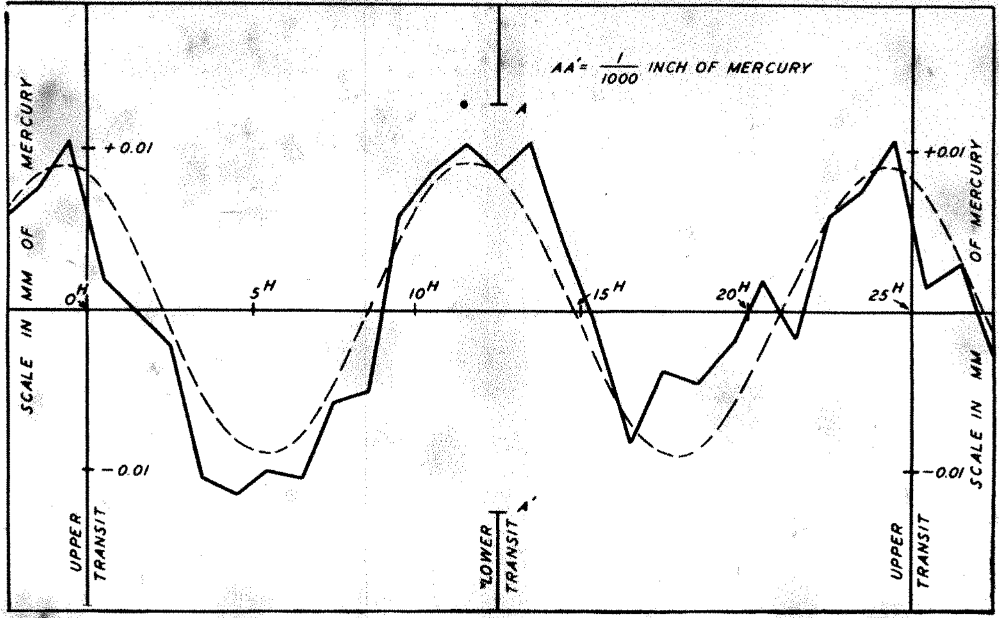

Fig. 1. THE LUNAR TIDAL BAROMETRIC VARIATION AT GREENWICH; ——, CURVE CALCULATED FROM THE HOURLY BAROMETRIC OBSERVATIONS; – – –, SEMI-DIURNAL COMPONENT OF THE CALCULATED CURVE

three years were by then available. Two thirds of the data were discarded, only those days being used on which the barometric range did not exceed 0·1 in. of mercury. Moreover, the last digit of the readings (made to 0·001 in.) was discarded. It was a remarkable illustration of the law of errors that the data, thus used only to 0·01 in., disclosed a lunar semi-diurnal variation of pressure (Fig. 1) of total amplitude less than 0·001 in., the average change from hour to hour being of order 0·0001 in.

Since 1918 the number of determinations of the lunar atmospheric tide has greatly increased, its present value being about fifty-four (forty-four in the northern hemisphere, ten south of the equator; fifteen tropical, thirty-nine in higher latitudes). Bartels has obtained three of these, Pramanik also three, Robb and Tannahill one, most of the others having been derived by Chapman and his colleagues at the Imperial College of Science and Technology, where the speed of the work was greatly increased after 1930 by the generous loan of a set of Hollerith machines by the British Tabulating Machine Company, Ltd.

Some of the results are summarized in Fig. 2, which shows a number of arrows on a Mercator map of the world. Each arrow represents in length (on the scale indicated) the semi-amplitude of the lunar tidal variation of the barometer at the place situated at the *centre* of the arrow; if the arrow is regarded also as the hour hand of a clock that keeps lunar time (so that the northerly direction on the chart would correspond to 12^{h} lunar, that is, upper or lower meridian passage of the moon), then the direction of the arrow indicates the time of maximum barometric pressure, or atmospheric high tide (lunar).

The chart shows that at most of the places considered the time of high tide is after lunar transit, by about 45 min. in the northern hemisphere, and 20 min. in the southern, where, however, there are large gaps in our knowledge; but there are stations where the tide is certainly early, before the moon's passage, namely, Mauritius (No. 45 on the chart) and Kimberley (No. 46). The tide is greatest in the tropics, but the decrease with increasing latitude is not regular: places in the same latitude may have decidedly different air-tides; for example, Buenos Ayres (47) and Melbourne (48). These irregularities are perhaps surprising, as the atmospheric ocean is not complicated by lateral boundaries.

The lunar atmospheric tide seems to vary in amplitude from apogee to perigee, with the changing distance of the moon, in much the way that tidal theory would suggest. But it has an unexpected variation also throughout the year, which is not seasonal, as it does not change when the sun crosses the equator; over most of the earth the tidal range is greatest at the June solstice; near the December solstice the lag after the moon is most pronounced, being more than half an hour later than the annual mean hour of tidal maximum. This change of the tide throughout the year still awaits an explanation.

Solar Daily Oscillations

Though in the oceans the daily changes of level are due primarily to the moon, in the atmosphere this is not so. The main periodic oscillation is solar semi-diurnal, with maxima in barometric pressure at about 10 a.m. and 10 p.m. local time. This is shown clearly in tropical barograph records, of which it is the main feature, except when hurricanes pass the station. In temperate latitudes it is obscured by the far larger irregular changes of pressure, but it is easily determined by averaging the data of many days.

Though the phase of this 12-hour (solar) wave in the barometric variation is remarkably constant over the belt between ± 50° latitude, with increasing latitude the oscillation tends to vary with *absolute* time, as first perceived by Greely. Through the work of Schmidt, Alt and Simpson, it has been shown that there are *two* solar semi-diurnal oscillations, one of tidal type, following the sun (and anti-sun) round the earth, the other being symmetrical about the earth's axis, and consisting of a 'zonal' oscillation of air between the equator and the poles. Simpson found that the corresponding two terms in the barometric variation are:

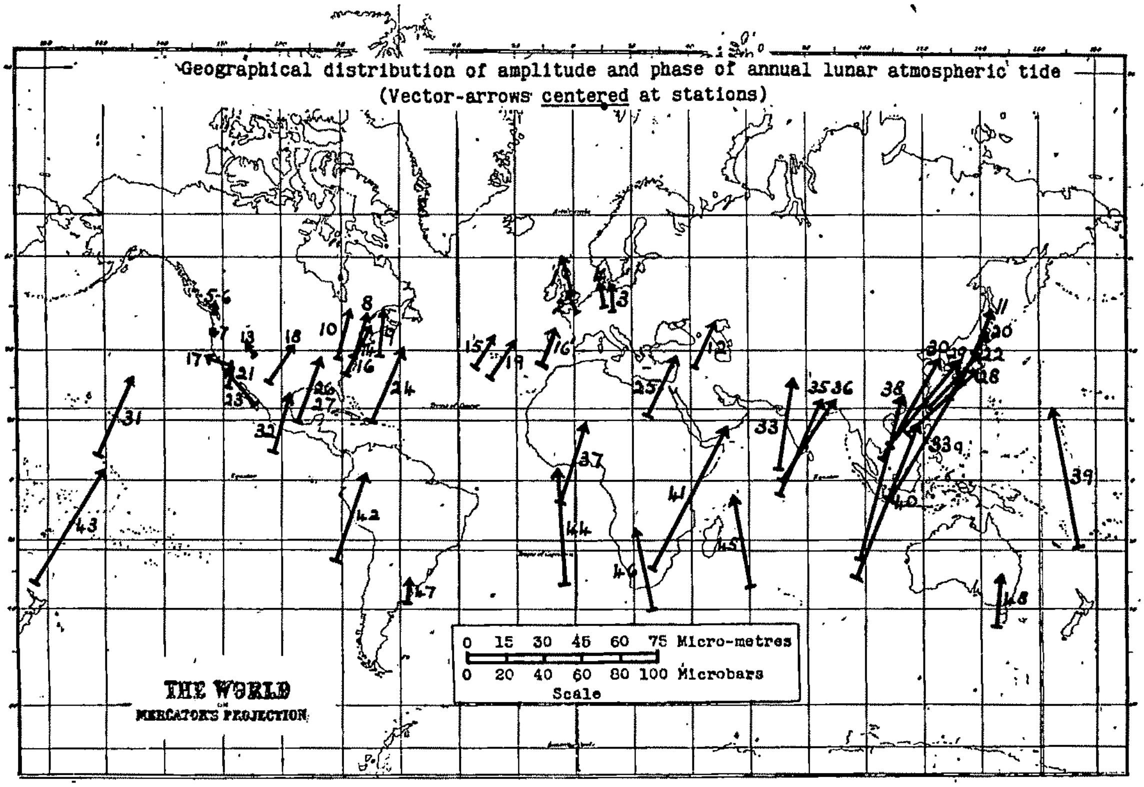
Geographical distribution of amplitude and phase of annual lunar atmospheric tide
(Vector-arrows centered at stations)
0 15 30 45 60 75 Micro-metres
0 20 40 60 80 100 Microbars
Scale
THE WORLD ON MERCATOR'S PROJECTION

Fig. 2

$$0{\cdot}937 \cos^3\varphi \sin(2t + 154^\circ) \text{ mm. of mercury}$$
$$\text{and } 0{\cdot}137(\sin^2\varphi - \tfrac{1}{3}) \sin (2t + 105^\circ - 2\lambda) \text{ mm.,}$$

where φ denotes the latitude, t the local mean solar time reckoned in angle at the rate 15° per hour, and λ denotes the longitude east of Greenwich. Thus at the equator the amplitude of the zonal part of the semi-diurnal oscillation is only 0·046 mm.

The solar 12-hourly oscillation, like the lunar tide, has an annual variation, mainly not seasonal; in phase the change is opposite to that for the lunar tide, the maximum pressure occurring earliest in December and latest in July or August. The amplitude varies less than in the case of the lunar tide; at many places it has two maxima in the year, near the equinoxes, and two minima near the equinoxes.

In addition, there is a fairly regular world-wide oscillation of period 8 (solar) hours, represented approximately in the barometric variations by a term of amplitude $0{\cdot}46 \sin\varphi \cos^3\varphi$ mm. in December; the phase is nearly opposite in the two hemispheres, and is nearly reversed from summer to winter.

Theory of the Oscillations

As Sir Geoffrey Taylor pointed out in the discussion, Laplace showed that in an *isothermal* atmosphere, oscillations involving no vertical motion, and in which the changes of volume occur *isothermally*, have the same free periods as those of corresponding mode (or geographical distribution) in a liquid ocean of a certain equivalent depth, which is actually the height of the equivalent homogeneous atmosphere. Margules developed the theory along these lines, stimulated by a hypothesis proposed by Kelvin, to explain why the solar semi-diurnal atmospheric oscillation so much exceeds the lunar (the ratio at the equator being about 15 to 1). Kelvin concluded that the former is of thermal origin, and that it is much magnified by resonance with a free period of atmospheric oscillation, of the same mode, very nearly approximating to 12 solar hours. Margules confirmed Kelvin's resonance hypothesis by finding a free period nearly coinciding with half a day. But this confirmation was unreliable, because the atmosphere and its oscillations are not isothermal, as Laplace's theory and Margules' calculations postulated.

Lamb investigated the horizontal propagation of plane waves in a non-rotating atmosphere on more realistic assumptions, taking into account vertical motion and adiabatic oscillations, but not the observed temperature-distribution with height. He then assumed that free oscillations of the atmosphere can exist which are identical in mode and period with those of an ocean of such depth that long waves are propagated in it with the speed that he calculated for plane waves. This assumption, which may be regarded as an extension of Laplace's theory of waves in an isothermal atmosphere, is not obviously true, since it involves the possibility that the atmosphere may have many equivalent depths, a contingency which is not possible in the case of an isothermal atmosphere. Lamb's assumption was later proved to be true by Taylor, who had used it previously to estimate the period to be expected in an atmosphere capable of carrying waves propagated at the speed observed in those produced by the Krakatoa volcanic eruption in 1883; Taylor concluded that the atmosphere has no free motion with a period so close to 12 hours as to fit Kelvin's resonance hypothesis. Later, however, he developed Lamb's work on oscillations having similar ground distributions but different height distributions of motion, taking account also of the cessation, at the tropopause, of the upward lapse of atmospheric temperature. Soon afterwards Pekeris applied Taylor's methods to determine the free periods of an atmosphere in which the stratospheric temperature again begins to increase upwards (as indicated by the abnormal propagation of sound to great distances) and then, still higher up, decreases once more. He showed that such an atmosphere could have a free oscillation of tidal type with a period very close to 12 hours, though the uncertainty of the upper atmospheric data as yet preclude the exact calculation of the period.

Tides in the Ionosphere

The calculations by Pekeris indicated that the amplitude of his free oscillation of nearly half-day period would increase greatly with height. Soon afterwards, Appleton and Weekes announced the astounding but well-authenticated discovery of a lunar tidal twice-daily rise and fall of the *E* layer of the ionosphere by nearly ± 1 km., indicating an enormous magnification of the lunar tidal oscillation at high levels, as compared with the ground.

The study of the lunar daily geomagnetic variations had already shown the existence of the lunar tide in an electrically conducting layer of the atmosphere, reasonably to be identified with the ionosphere. The theory of these variations was in some ways rendered easier by the discovery of the large tide in the *E*-layer, which lessened the rather difficult demands made by the theory on the conductivity of the layer. The *E*-layer tide, however, was in phase with the moon, whereas the magnetic variations indicate an oscillation of opposite phase.

New Calculations of the Forced Oscillations

This interesting and complex situation as regards the facts and the theory of the atmospheric oscillations and their ionospheric effects calls both for further observations (in particular, as to the thermal structure of the atmosphere up to ionospheric levels) and renewed theoretical studies of the oscillations. Dr. M. V. Wilkes and Mr. K. Weekes described their new studies of this kind. The main input of tidal and thermal energy into the atmospheric oscillations is near the ground; energy passes upwards from thence, as if propagated in a medium with refractive index μ given by

$$\mu^2 = -\frac{1}{4} + \frac{1}{h}\left(\frac{\gamma - 1}{\gamma} H + \frac{dH}{dx}\right),$$

where γ is the usual specific-heat ratio, x is a co-ordinate depending on the height, H the scale height ($RT/\overline{m}g$) and h the equivalent height of the ocean with the same free period for the type of oscillation considered. If the distribution of temperature T (or $T/\overline{m}$, where $\overline{m}$ denotes the mean molecular weight) makes μ^2 negative at a certain layer, this acts as a barrier against upward propagation, like a total reflector, and resonance may occur. Using this method of approach, it is possible to see on general grounds that if the resonance theory is accepted the temperature in the atmosphere must be assumed to fall again (for example, to 200–240° K.) above the first hot layer in the stratosphere. The boundary condition applied at high levels is that the flow of energy is upward. The energy is finally lost in the region above 150 km., where the kinematic viscosity becomes so great as to cause heavy damping of the waves.

Mr. Weekes described the strenuous efforts made to find temperature–height distributions consistent with the high resonance of the solar half-daily oscillation at the ground, and of the lunar tidal oscillation in the ionosphere. Taking the stratospheric temperature to rise from 220° K. to 400° K. in the layer between 33 and 45 km. height, and then to fall to 200° K. (as suggested by the work of Ratcliffe, Budden and Wilkes on the propagation of long radio waves), the oscillation at about 100 km. was found to be reversed, agreeing with the indications of the lunar tidal geomagnetic variation. This reversal of phase at high level, which was first found by Pekeris, is in contradiction to the experimental results of Appleton and Weekes. Further calculations have shown, however, that this discrepancy is not a fundamental one and can be resolved, for example, if the temperature is assumed to rise again to a further maximum in the *E* region.

It may be expected that in the fairly near future the temperature–height distribution in the atmosphere will be actually measured by V2 rocket methods. This will remove much that is now tentative in the theory of these atmospheric oscillations; but it remains to be seen whether the many pieces of evidence will then combine to form a clear co-ordinated picture, or whether discrepancies will persist and call for further search and effort.

S. CHAPMAN

HISTORY AND WORK OF THE PALÆONTOGRAPHICAL SOCIETY

MARCH 23 marks the hundredth anniversary of the foundation of the Palæontographical Society, the only Society which devotes all its resources to the illustration and description of British fossils. Members will celebrate this centenary of scientific work by holding the hundredth annual general meeting on the morning of Monday, March 31, when the present president, Prof. H. L. Hawkins, professor of geology in the University of Reading, will deliver a commemorative address; in the afternoon, a public lecture will be delivered in the lecture room of the Geological Survey Museum, and in the evening, members will dine at the Hall of the Worshipful Company of Tallow Chandlers, Dowgate Hill, London.

Several years before the foundation of the Society, a group of seven enthusiasts had common interests in the study of Tertiary fossils, and acted together under the name of the London Clay Club; for the most part, their rich collections of fossils passed eventually to the British Museum (Natural History). The leading spirit of this club was J. S. Bowerbank (1797–1877), a well-to-do London distiller, keenly interested in many sciences, who in 1839 was one of the founders of the Royal Microscopical Society. The other members were F. E. Edwards (1799–1875), a solicitor; John Morris (1810–86), then a Kensington pharmacist; J. de C. Sowerby (1787–1871), a naturalist who was continuing the illustration and publication of the "Mineral Conchology" started in 1812 by his father, J. Sowerby; N. T. Wetherell, M.R.C.S. (1800–75), of Highgate; S. V. Wood (1798–1880), a retired officer of the Merchant Navy; and Alfred White. The members of this Club contributed papers to the learned societies and periodicals, and occasionally unique fossils from their collections were illustrated and described in the "Mineral Conchology"; this publication, however, with its 649 hand-coloured octavo plates issued over thirty-seven years in 113 instalments, had no particular systematic arrangement; furthermore, it was waning in frequency of appearance, and between 1835 and 1845 only thirty-nine plates were published. In 1845 its publication ceased; and in the following year, G. B. Sowerby and Son issued a fly-leaf inviting subscriptions for the first number, price five shillings, of a royal quarto publication to be called "Fossils of the British Strata Illustrated and Described" and to be issued on January 1, 1847, and on the first day of alternate months. The first works promised were fossils of the Crag (shells and other invertebrates by S. V. Wood, Echinodermata by E. Forbes), also fossils of the London Clay (shells by F. E. Edwards, Echinodermata by Forbes). A specimen plate of the Crag fossils was exhibited at the British Association meeting held in September 1846 at Southampton. The publication did not materialize on January 1, 1847, but the concept grew and the promised works appeared later; for, on February 3 of that year, during the tea following the reading to the Geological Society of J. Prestwich's paper "On the Probable Age of the London Clay and its Relation to the Hampshire and Paris Tertiary Systems", with the collaboration of Edward Forbes, palæontologist to the Geological Survey, Bowerbank "solicited the leading geologists present to support him in establishing a Society for the publication of undescribed British fossils" (*Geol. Mag.*, 192; 1877).

As a sequel, a meeting was held on March 23, 1847, in the Geological Society's apartments, then in Somerset House, to establish a Society, "to figure and describe as completely as possible a stratigraphical series of British Fossils". The chair was taken by Sir Henry De la Beche, director of the Geological Survey and president of the Geological Society. The new society was named the Palæontographical Society, and it was resolved that an annual subscription of one guinea, paid in advance, on the first day of January each year, entitled a member to the publication issued by the Society for that year. The business was to be conducted by a president, treasurer, secretary and sixteen members of council to be elected annually at a general meeting. The foundation resolutions are still adhered to by this Society, and the Geological Society continues to offer the hospitality of its apartments for council and general meetings and for storing sales stock.

Those elected as officers and council of the Society at its inaugural meeting included several who were among the seventy-five authors of the eighty-two monographs eventually embarked upon by the Society; in the list that follows, the subjects and dates of issue of such monographs are indicated in brackets. President, Sir Henry De la Beche, F.R.S.; Treasurer, S. V. Wood (Crag Mollusca, 1848–82; Eocene Bivalves, 1861–77); Secretary, J. Morris (with J. Lycett, Great Oolite Mollusca, 1851–63). Council: Prof. T. Bell, F.R.S. (Malacostracous Crustacea, 1858–62; with R. Owen, London Clay Reptilia, 1849); J. S. Bowerbank, F.R.S., who within six weeks was elected secretary; F. E. Edwards (Eocene Mollusca, 1849–77); Sir Philip de M. Egerton, M.P., F.R.S., collector and authority on fossil fishes; H. Falconer, M.D., F.R.S., distinguished for his work on fossil mammals; W. H. Fitton, M.D., F.R.S., a pioneer in the study of the British Cretaceous and Upper Jurassic strata; J. W. Flower of Croydon; Prof. E. Forbes, F.R.S. (Tertiary Echinodermata, 1852); Capt. L. L. B. Ibbetson, who, according to Buckland, had applied a "photogenic process for rapidly producing perfect drawings of fossil shells on metallic plates from which when fixt by the engravers tool, lithographic transfers may be rapidly multiplied to an almost indefinite extent"; C. Lyell, F.R.S., renowned for his text-books and for his definition of the Eocene, Miocene and Pliocene formations; Prof. J. Phillips, F.R.S. (British Belemnites, 1865–70), with Conybeare, the first to define the Carboniferous System and its main subdivisions; J. Prestwich, authority on the Pleistocene, Tertiary and Coal Measures; D. Sharpe (Chalk Mollusca, 1853–57); J. Smith, F.R.S., of Jordanhill, Glasgow, who studied the Pleistocene; N. T. Wetherell, many of whose Tertiary fossils were illustrated in the Society's monographs, and A. White. The last surviving member of this illustrious council, Sir Joseph Prestwich, died on June 23, 1897, four days after the Society's fiftieth anniversary had been celebrated.

At early council meetings, the format of publication was adopted as quarto demy, and offers of monographs were considered; G. B. Sowerby was commissioned to undertake copper-plate engraving, and Messrs. Adlards were engaged as printers; this last engagement has been unbroken for the hundred years. Special recruiting meetings were held at the British Association meeting at Oxford in 1847 and again at the Association's meeting at Swansea in 1848, by which time Volume 1, containing the first part of S. V. Wood's "Monograph of Crag Mollusca", had been distributed to nearly six hundred members. Local secretaries, who assisted in the distribution of the volumes to members, numbered thirty-eight. As would be expected from the circumstances preceding the Society's formation, monographs dealing with Tertiary fossils were prominent in early volumes; these included a monograph by Charles Darwin dealing with fossil Cirripedes; by 1851, however, William King's "Permian Fossils" had been completed, and other major productions such as Milne Edwards and J. Haime's "Fossil Corals" and T. Davidson's "Fossil Brachiopoda" had been commenced. This last is unique among the Society's publications, since its range is from Cambrian to Pliocene; it is illustrated by drawings made on stone by Davidson himself, and it continued publication until 1885, giving description and illustration to some 960 species. Most of the monographs cover considerably shorter time-ranges; but rarely do they range below the stratigraphical unit of series.

It has been said that at the period of the Society's formation, opinion was held that the work should be ended within twenty-five years, presumably because the species then known were few. The number now described is uncounted. Morris's "Catalogue of British Fossils" in its 1854 edition listed but 8,359; by 1886, however, Etheridge estimated them at 19,022, and up to 1897 the Society was stated to have illustrated and described only some 6,988 species. Since that time, monographs current then have been finished, and twenty-five new works either have been completed or are still in progress. Several of the older as well as some of the modern monographs have had a considerable influence on both stratigraphy and palæontology; in 1899, the science's historian, K. A. von Zittel, recorded that the publications held the foremost place among periodicals dealing with palæontology. There remain, however, a few groups of fossils still virtually untouched by the Society, and certain monographs need revision; these defects are being remedied as specialists become available and willing to undertake such work. Preparation is being made for the issue of nomenclatorial supplements to early monographs, and a new monograph on Carboniferous Crinoidea is promised publication in the near future.

The Society came into being when there were many collectors anxious to identify their finds, and the membership remained between five and six hundred during the first fifty years of the Society's history; there was, however, during that time a steady rise in the proportion of library subscribers. In the first thirty years of the present century, there was a marked fall in numbers of personal members, but the figures have lately shown a slight rise. The fall in membership as well as the rise in cost of printing has resulted in a decrease in thickness of the annual volume, because it was thought desirable not to increase the original subscription rate.

The Society has had ten presidents: Sir Henry De la Beche (1847–55); W. J. Hamilton (1856–67); Dr. J. S. Bowerbank (1867–77); Sir Richard Owen (1877–92), who was responsible for eight monographs on fossil Reptilia and Mammalia; T. H. Huxley (1893–5); Dr. H. Woodward (1896–1921), who wrote three monographs dealing with Palæozoic Arthropoda, one in association with T. R. Jones; E. T. Newton (1921–28); Dr. F. A. Bather (1928–34); Sir Arthur Smith Woodward (1934–44). The treasurers have been seven: S. V. Wood (1847–80); S. V. Wood, jun. (1880–84); R. Etheridge (1884–1904); Dr. G. J. Hinde (1905–14), who wrote a monograph on fossil sponges; R. S. Herries (1914–38); W. E. F. Macmillan (1938–46). The secretaries, who also serve as editors, have been five: J. Morris (1847, for a few weeks); J. S. Bowerbank (1847–63); Rev. T. Wiltshire (1863–1900); Sir Arthur Smith Woodward (1900–34), who during this period completed two monographs on fossil fishes. The present office holders are: President, Prof. H. L. Hawkins (1944–); Treasurer, Dr. A. J. Bull (1946–); Secretary, Dr. C. J. Stubblefield (1934–).

C. J. S.

OBITUARIES

Brigadier H. St. J. L. Winterbotham, C.B., C.M.G.

Harold St. John Lloyd Winterbotham died on Tuesday, December 10, 1946, at his home at Sutton Courtenay at the age of sixty-eight. He was the second son of Canon R. Winterbotham, was born on February 5, 1879, educated at Fettes and the Royal Military Academy, Woolwich, and commissioned in the Royal Engineers in 1897. He was awarded the Queen's Medal with three clasps for his services in the South African War, and when the War ended was appointed garrison adjutant at St. Helena. After a short period of home service he returned to South Africa in 1908, where he carried out a topographical survey of the Orange Free State.

In 1911 he joined the Ordnance Survey at Southampton, where he was placed in charge of the Trigonometrical and Topographical Division. Some doubts had been expressed about the accuracy of the Principal Triangulation of Great Britain, which had been carried out about a hundred years before. It had already been decided to carry out a check, and a new base had been measured at Lossiemouth before Winterbotham arrived. He took charge of the remaining operations required to complete the check of the old work, and published an important professional paper describing the results. This indicated that the Principal Triangulation was comparable in accuracy with work carried out on the Continent by the most modern methods.

Soon after the outbreak of war in 1914, Winterbotham left Southampton for France in command of the Ranging Section R.E., a small unit intended to be used for fixing the position of an aeroplane at the instant that it dropped a smoke signal over a hostile target. This small unit was the nucleus which, in conjunction with "Maps G.H.Q.", grew into the large military survey organisation which existed in the field in 1918. In this organisation Winterbotham served first in command of the 3rd Field Survey Company and later as technical assistant to the Officer in Charge of Maps G.H.Q., with a short interval during which he was in charge of Survey at G.H.Q. Italy. For his services he was mentioned three times in dispatches, was made a C.M.G. and received the D.S.O. and the brevet of lieutenant-colonel.

In 1920 Winterbotham returned to his old post in the Trigonometrical Division of the Ordnance Survey. In 1922 he became chief of the Geographical Section, General Staff, a post which he retained until 1929. During this time he was jointly responsible with Colonel (later Sir Charles Arden) Close for the production of the third edition of the "Text-Book of Topographical Surveying", and he also published "Survey Computations", a book of great value to the field surveyor whether military and civil.

At this time a revolutionary alteration in the design of theodolites had been made on the Continent, and British models were in danger of being completely outclassed. It was on Winterbotham's initiative that a conference was called at Tavistock to consider the design of a new British instrument. This was attended by representatives of the Services and of the leading survey instrument manufacturers, and led to the production of the Tavistock theodolite by the firm of Cooke, Troughton and Simms, to the great advantage of British surveyors in the Second World War.

During his term at the War Office, Winterbotham's interest in geodesy not only led him to take an active part in the affairs of the International Union of Geodesy, but also he was responsible for sending a party to Africa to complete the geodetic observations of a section of the arc of the 30th meridian. During this time, too, he was one of the original founders of the Field Survey Association, the success of which owed much to his energy.

Following his term at the War Office he carried out an inspection of Colonial survey departments, and included in his tour a visit to the party of Royal Engineers which he had been responsible for sending out to carry out the trigonometrical observations of the arc of the 30th meridian in Africa.

In 1930 Winterbotham was appointed director-general of the Ordnance Survey, and the following year became A.D.C. to the King. His time at the Ordnance Survey was one of severe financial stringency, when establishments were cut to the bone. Opportunities for carrying out any original work, or indeed anything but routine revision, were few. Fortunately for the Ordnance Survey, Winterbotham was able to find time for a study and overhaul of old records. His most important publication at this time was "The National Plans", which gives a very complete historical description of the large-scale plans of the Ordnance Survey. His work on this and other publications came to be fully appreciated by those who had to restart the Ordnance Survey on its national work after the Second World War. With many files and records destroyed during the War and a seven years gap in the continuity of the work, the existence of those carefully prepared historical studies was an inestimable boon. In 1935, having reached the age limit, Winterbotham retired from the Army and from the Ordnance Survey. In the same year he was made a C.B.

But the energy which had so far been mainly directed to the execution of his official duties was now more fully available for that work for the International Union of Geodesy and Geophysics which had always been one of his principal interests. In the early general assemblies of the Union his professional co-operation had been much in demand by the Governments he had advised and assisted in survey work. At the third assembly in Prague (1927), we find him entrusted with the representation of South Africa, Australia and Canada, as well as the General Staff of the War Office.

Then in 1928, when Colonel (later Sir Henry) Lyons succeeded Sir Arthur Schuster as general secretary of the International Research Council and resigned the general secretaryship of the International Union of Geodesy and Geophysics, Winterbotham accepted an invitation to succeed him; and from the following assembly at Stockholm in 1930 until his death, Winterbotham's interests and enthusiasms were seldom far from the Union. There he guided and humoured successive presidents and executive committees and helped the secretaries of the constituent associations not quite so experienced or so expert in administrative matters as himself—all with a friendly kindliness which did not stop him from frank expression of opinion when he considered the real interests and welfare of the Union to be at stake.

Winterbotham's wide experience of men and affairs stood the Union in excellent stead during the war years. Immediately after the Washington assembly in September 1939, from which he was recalled for official duties, Winterbotham took steps to safeguard the international interests and widely distributed funds of the Union and of its various associations. It is largely owing to his judgment and foresight that the International Union of Geodesy and Geophysics came through the war years ready to undertake fresh international scientific work. Meanwhile he had offered his services to the Government and had been employed, first as chief instructor in survey at the School of Military Engineering, and later under the Admiralty on the preparation of topographical reports.

Before the War had properly ended, Winterbotham set about gathering together again the broken threads of international geodetic and geophysical collaboration. At a meeting of the executive committee of the Union which he was instrumental in calling together in 1945, plans were discussed for early renewal of the Union's activities. By that time, unfortunately, Winterbotham had been advised that he must take things more easily, and it was with great regret that the committee accepted his resignation. At the subsequent extraordinary assembly of the Union in August 1946, Winterbotham was honoured by election as one of the two vice-presidents of the Union under the new statutes in the framing of which he himself had spent much thought and care. By this election the assembly hoped that his ripe experience and judgment in Union affairs would continue at the disposal of the Union for many years; but, though not known to many, he was already a sick man, and he did not live to contribute still further to the Union's international prestige, which he had done so much to enhance during his long and active association with it.

There will be many people in many lands who will remember Winterbotham's sage counsel given in a characteristic and incisive style, and there will be many who will miss that counsel in the years to come. He leaves a widow, one son and two daughters.

G. CHEETHAM

Dr. C. T. Madigan

BY the death of Cecil Thomas Madigan, Australian geology has been deprived of one of its most colourful personalities, a man who throughout his entire life had retained the youthful spirit of the true pioneer and explorer. Born on October 15, 1889, the son of Thomas Madigan of Renmark, South Australia, he was educated at the University of Adelaide, where he was known as a first-class oarsman.

Although elected to a Rhodes Scholarship at Oxford in 1911, Madigan did not go into residence until 1914, in the meantime having accompanied Sir Douglas Mawson as his second-in-command on the Australian Antarctic Expedition. On the outbreak of war not long after his arrival in Oxford, he was granted a commission in the Royal Engineers, with whom he saw four years service in France, being twice wounded and gaining a mention in dispatches.

On demobilization in 1919, Madigan returned to Oxford and obtained a first-class in the final honour school of geology. While carrying out research on material brought back from the Antarctic, he was appointed assistant Government geologist in the Sudan, where he spent two years before returning to Adelaide to become senior lecturer in geology, a post he held until his death. During the Second World War Madigan again joined the Forces, and with the rank of lieutenant-colonel was chief instructor of the School of Military Engineering at Liverpool, New South Wales, for three years.

The greater part of Madigan's work was devoted to the exploration of what Gregory had aptly termed the "Dead Heart of Australia". In 1929 he made the first aerial reconnaissance of this *terra incognita*, exploring an area of some 28,000 square miles which no white man had ever seen and which had previously baffled all attempts to cross it. He proved that the great lakes were dry, and that nothing lay within the area other than clay-flats encrusted with salt and everlasting sand-ridges; having had, in his own words, the somewhat melancholy satisfaction of saving the danger and expense of further exploration.

By this and subsequent journeys with car or camels, Madigan obtained a vast amount of valuable geological and topographical information, extending as far north as the MacDonnell Ranges and the area north of Lake Eyre, which he named the Simpson Desert; and the account he has given of this most inhospitable country in numerous papers published by the Royal Society of South Australia, the Royal Geographical Society and the Geological Society of London makes the most interesting reading. Some of his remarkable aerial photographs were recently published in the *Illustrated London News* (January 25, 1947).

In 1915 Madigan married Wynnis Wollaston, by whom he had three sons and two daughters, all of whom survive him. While grieving his loss, his many friends may be comforted by the thought that one who loved the wide open spaces was spared possibly many years of enforced inactivity. He has left behind a record of service to his country of which any man might well be proud. J. A. DOUGLAS

Prof. P. J. Daniell

PROF. P. J. DANIELL, professor of mathematics in the University of Sheffield, died on May 25, 1946, at the age of fifty-seven. He was educated at King Edward VI School, Birmingham, and at Trinity College, Cambridge. He was Senior Wrangler in 1909, the last year in which the names of the candidates in Part 1 of the Mathematical Tripos were placed in order of merit. In Part 2 of the Natural Sciences Tripos in 1910 he obtained a first class, and in 1912 he was awarded a Rayleigh Prize. After studying in Göttingen for two years and then acting as an assistant lecturer at the University of Liverpool, he went to the Rice Institute, Texas, where he was professor of mathematics until 1923. In that year he returned to England as professor of mathematics in Sheffield, and held this post until his death. In the summer of 1945 he had a serious illness from which he did not fully recover, and he died about a year later after a sudden relapse.

Prof. Daniell was a distinguished scholar of pure and applied mathematics. The most important of his earlier contributions to mathematical knowledge were related to generalized integrals and derivatives. He extended the Radon–Young integral to space of an infinite number of dimensions, and his integral was applicable, for example, in the theory of functionals. He considered also generalized derivatives, using methods that were based partly on Young's work in one dimension and partly on ideas introduced by himself. His research, however, extended over a wide field of applied science, and much of his time and energy were spent in assisting and advising research workers in a variety of problems. His mathematical investigation on the propagation of flame motion, for example, was related to experimental work carried out by the Safety in Mines Research Board in Sheffield. Perhaps his most important work of this kind was that done during the War, when he was engaged in problems arising from the control of instruments designed to pick up and locate targets such as aeroplanes and ships. He assisted in the work of improving the performance of such instruments, and he was a leading exponent of the frequency response approach to the problems involved in the design of these instruments. He initiated methods in dealing with problems of back-lash, and he assisted the Admiralty in ultra-high-frequency detection methods.

In educational affairs generally, Daniell took an active share in addition to his university activities. He was the representative of the University of Sheffield for more than twenty years on the Joint Matriculation Board, and took a significant part in shaping its policy.

His death means a great loss to the mathematical world, but he is especially missed in the University of Sheffield, where his experience and wisdom would have been of great value in guiding the developments now in progress.

NEWS and VIEWS

Library of Sir James Hall, Bart., of Dunglass, Haddingtonshire

IN the last week of February, Messrs. Hodgson and Co., of Chancery Lane, London, offered for sale the library accumulated at Dunglass House, in East Lothian, in the latter half of the eighteenth and the earlier part of the nineteenth century by Sir James Hall (1761–1832), the distinguished geologist, and other members of his family. The collection contained many early and important works in various branches of science and in medicine, but was of more particular interest on account of the geological works included. Hall was a pioneer in experimental geology, and carried out a number of classic laboratory experiments devised to support some of the conclusions reached by his friend James Hutton, from general reasoning based on geological field work, and embodied by the latter in his "Theory of the Earth". One series of experiments was designed to show that molten basalt lava, when cooled slowly, forms a stony or crystalline mass comparable with the basalt occurring in Nature, rather than a vitreous mass, as was usually contended at that time. The second and more famous series was instituted to determine the combined effects of heat and pressure on carbonate of lime, the problem being to find out if powdered chalk could be converted into firm limestone or into marble by heating in a confined space. Hutton's view that marble would result was based on geological grounds, but was apparently at variance with experimental facts, as then known. Some preliminary trials were carried out during Hutton's lifetime, but a more prolonged and systematic series of experiments was not commenced until after the latter's death, having been postponed in deference to his marked disapproval of those who "judge of the great operations of the mineral kingdom by kindling a fire and looking into the bottom of a crucible".

The main experiments, which proved entirely successful in their object, were carried out during the period 1798–1805; and full details were recorded by Hall, in the form of a diary, in two folio volumes. These are the volumes which appeared in the sale room as Lot 98, bearing the title "Chemical Experiments made with a view to Obviate some of the Difficulties in Dr. Hutton's 'Theory of the Earth' ". It is a matter for satisfaction to be able to record that these diaries were purchased by Messrs. Quaritch on behalf of the National Library of Scotland, where they will now find a permanent and appropriate resting place. Among other works of interest sold, the writings of James Hutton were well represented, not only by his lesser-known books, but by two copies of his famous "Theory of the Earth". The publication of this book, in 1795, has long been recognized as a landmark in the history of geology. The prices obtained, £110 for one copy and £95 for the second, reflect not only its scientific importance but also its great rarity.

Dr. T. W. King (1809–47)

Thomas Wilkinson King, who died of pulmonary tuberculosis on March 26, 1847, may without undue straining of the phrase be hailed as the 'father of endocrinology'. Such an appellation is justified by his paper "On the Structure and Function of the Thyroid Gland" (*Guy's Hospital Reports*, 1, 429; 1836), in which he described the colloid secretion of the thyroid and which is remarkable for this prophetic sentence: "We may one day be able to show that a particular material is slowly formed and partially kept in reserve, and that this principle is also supplementary, when poured into the descending cava, to important functions in the course of the circulation". This original article remained almost completely forgotten until it was rescued from obscurity by Sir Humphry Rolleston (Fitzpatrick Lectures, 1933). The son of a medical practitioner at Dover, at the age of sixteen King entered Guy's Hospital, on October 4, 1824. In 1837 he succeeded Thomas Hodgkin as curator of the museum and lecturer on morbid anatomy, assuming the additional lectureship on comparative anatomy and physiology three years later. As a lecturer he was not popular, for he was a poor speaker and inclined to be over the head of the average student. A tireless worker, he founded his many novel theories on clinical observations which he verified experimentally. On December 11, 1843, King became one of the original fellows of the Royal College of Surgeons of England. He was then practising at 36 Bedford Square, London; it is recorded that "Though young, he had an aged, worn look", and a perpetual cough.

World Federation of Scientific Workers

Mr. J. G. Crowther has been appointed secretary-general designate of the World Federation of Scientific Workers. Mr. Crowther was during the War in charge of the Science Department of the British Council and is the author of several books on the history and social relations of science. The World Federation of Scientific Workers was founded last year at a conference convened by the Association of Scientific Workers in Great Britain and attended by representatives of many foreign associations of scientific workers. It is intended to serve as a centre through which the various national associations may render each other mutual advice and encouragement, to help the growth of the individual associations in their own countries, and to assist them to work out common aims and methods of organisation. It is preparing a charter of the rights and duties of scientific workers. The constituent associations work towards an agreed policy on matters of fundamental importance such as secrecy, and freedom and co-ordination in scientific research. The president of the Federation is Prof. F. Joliot-Curie, High Commissioner for Atomic Energy in France. Communications can be sent to the London office, at 15 Half Moon Street, London, W.1, or to M. P. Bonet-Maury, Institut du Radium, 11 rue Pierre Curie, Paris, V^e.

Chemicals from Petroleum

At a meeting held at the Mayfair Hotel, W.1, on March 11, an announcement was made by the Shell Petroleum Co., Ltd., of a new and extended programme for the production in Great Britain of chemicals from petroleum. In the past the main sources from which organic chemicals have been derived are coal by-products and fermentation processes. The petroleum to be used as the new raw material will be imported from sterling areas, and the productive capacity of the Shell organisation in the United Kingdom is to be expanded to give a greatly increased output. This venture has been facilitated by the exemption from import and excise duty of hydrocarbon oils used as raw material for processes of chemical synthesis. By the use of modern methods and equipment it is claimed that a high output per man will be achieved. Among the basic chemicals to be produced are acetone, methyl ethyl ketone, methyl *iso*butyl ketone, *iso*propyl alcohol, diacetone alcohol, *sec.*-butyl alcohol, *tert.*-butyl alcohol, mesityl oxide, methyl *iso*butyl carbinol and *iso*propyl ether. A big expansion in the production of sodium higher alkyl sulphates, used as detergents and wetting agents, is envisaged, the method of manufacture being based on the vapour phase cracking of a petroleum wax to produce higher olefines. Further developments include the manufacture of insecticides, fungicides and other products used in agriculture; and an experimental farm has been acquired at Woodstock, Kent, where a study can be made of the application of new products to a variety of agricultural and horticultural purposes. Owing to the absence of natural gas resources in Great Britain, the production of chemicals from petroleum in this country calls for different manufacturing methods for the basic olefines from those generally followed in the United States of America.

The Fertiliser Society

It has long been felt by the various sections of the fertiliser industry that, as in other progressive industries, there was a need for a technical society to serve the personnel of the industry and to deal with technical problems. On the initiative of the Fertiliser Manufacturers' Association, therefore, representatives of the Basic Slag Producers' Association, the British Sulphate of Ammonia Federation, the Federation of Bone Users and Allied Trades Ltd., and the Horticultural Fertilisers Association Ltd., met recently to discuss proposals. The formation is now announced of the Fertiliser Society, having as its objects: (1) the provision of a medium for discussion of scientific and technical aspects of the production, use and application of fertilisers; (2) the promotion of the interchange of views and the dissemination of information to members concerning such scientific and technical aspects. Membership is open to persons engaged in, or associated with, the manufacture of fertilisers, and such other persons as the Council from time to time approve. The secretary is Dr. G. F. New, and the offices of the Society are at 44 Russell Square, London, W.C.1.

Health and the Suppression of Dust in Mines

The relation of dust to the health of mine-workers will be the subject of meetings to be held at the Royal Institution during April 15–17. On April 15, at 5.0 p.m., the first Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy will be delivered by Major-General A. J. Orenstein, chief medical officer of Central Mining—Rand Mines, Ltd., who will speak on "The History and Prevention of Silicosis with special reference to the Witwatersrand". The lecture will be open to the public, without ticket. During April 16–17, a Conference on Silicosis, Pneumokoniosis and Dust Suppression in Mines, arranged by the Institution of Mining Engineers and the

Institution of Mining and Metallurgy, will take place. There will be four sessions, the first two dealing with medical aspects, and the third and fourth with dust sampling and control. There is no fee for attending the Conference; a volume of proceedings will be published as soon as possible after the meeting. Particulars can be obtained from either of the organising Institutions, Salisbury House, Finsbury Circus, London, E.C.2.

German Scientific Periodicals

We have received a list of ninety German scientific periodicals for which permission to begin publishing has been obtained from the Control Commission. About a quarter of these have already been started. Among them are a number of journals which existed before the War, such as *Die Naturwissenschaften*, published with Prof. A. Eucken of Göttingen as editor, *Metallforschung* under Prof. Masing's direction, and also a considerable number of medical journals. Messrs. Springer intend to restart *Zeitschrift für Physik*; but this apparently has not yet begun. A new journal containing interesting articles by a number of well-known physicists is *Zeitschrift für Naturforschung*, published by Dieterich'sche Verlagsbuchhandlung, Wiesbaden (see *Nature*, Sept. 14, p. 372).

Association of British Zoologists

At the annual meeting of the Association of British Zoologists held in the rooms of the Zoological Society on January 11, the following were elected officers and new members of the council for the year 1947–48: *President*, Dr. Edward Hindle; *Hon. Secretary*, Dr. D. L. Gunn, Anti-Locust Research Centre, British Museum (Natural History), Cromwell Road, London, S.W.7; *Hon. Treasurer*, Dr. A. G. Hamilton, Royal Veterinary College, Royal College Street, London, N.W.1; *New Members of Council*, Prof. H. Gordon Jackson (re-elected under provisions of the constitution), Prof. C. M. Yonge, Dr. J. W. Evans, Dr. A. Graham and Mr. G. P. Wells. A discussion on "Careers in Zoology—Possibilities and Training" took place, an account of which is reported on page 378 of this issue of *Nature*.

Royal Society of Edinburgh: New Fellows

The following have been elected fellows of the Royal Society of Edinburgh: Mr. F. W. Anderson, senior geologist, H.M. Geological Survey, palæontologist in Scotland, Edinburgh; Dr. J. G. C. Anderson, senior geologist, H.M. Geological Survey, Edinburgh; Dr. R. N. Arnold, regius professor of engineering, University of Edinburgh; Mr. Hamilton Bailey, Denham, Totteridge, London, N.20; Dr. G. H. Bell, senior lecturer in physiology, University of Glasgow; Dr. W. P. Blount, poultry adviser to Unilever Group, Stoke Mandeville, Bucks; Dr. N. L. Bor, Forest Research Institute, Dehra Dun; Dr. L. M. Brown, lecturer in technical mathematics, University of Edinburgh; Dr. W. F. Cassie, professor of civil engineering, King's College, University of Durham; Dr. S. C. Curran, lecturer in natural philosophy, University of Glasgow; Dr. J. H. Fraser, member of scientific staff, Marine Laboratory, Aberdeen; Prof. Tom Grahame, Anatomy Department, Royal (Dick) Veterinary College, Edinburgh; Dr. G. Heslop Harrison, University of Durham; Dr. J. A. Hewitt, senior lecturer in physiology, King's College, University of London; Dr. J. M. Hyslop, lecturer in mathematics, University of Glasgow; Dr. J. M. Jackson, lecturer in mathematics, University College, Dundee; Dr. Otto Löwenstein, lecturer in zoology, University of Glasgow; Dr. A. J. Macintyre, lecturer in mathematics, University of Aberdeen; Group Captain G. S. Marshall; Dr. James Reekie, lecturer in physics and Carnegie Teaching Fellow, University of St. Andrews; Mr. J. M. Muirhead, manager, Scottish Provident Institution, Edinburgh; Mr. W. H. Senior, assistant secretary, Department of Agriculture for Scotland, Edinburgh; Dr. A. K. M. Trivedi, professor of chemistry, Lingraj College, Belgaum, India; Dr. G. R. Tudhope, lecturer in pathology, University of St. Andrews, and pathologist, Royal Infirmary, Dundee; Dr. B. Woolf, lecturer in vital statistics, Department of Public Health, University of Edinburgh.

Announcements

The Council of the Royal Society of Edinburgh has awarded the Makdougall–Brisbane prize for the period 1944–46 to Dr. William Black, of the Scottish Society for Research in Plant Breeding, for his work dealing with genetical investigations on the potato, with their practical applications.

The Textile Institute has awarded a scholarship, offered under the terms of a grant from the Cotton Trade War Memorial Fund (total value £750, tenure three years), to George H. Ewins, a cotton-spinning student at Bolton Municipal Technical College, who will now proceed to a university degree course.

Dr. William A. Hamor, an assistant director of the Mellon Institute of Industrial Research, Pittsburgh, has been given the honorary degree of doctor of laws of the University of Miami.

The Bristol, Clifton and West of England Zoological Society has agreed to provide funds for a research scholarship in vertebrate zoology tenable at the University of Bristol at the rate of £300 for three years. Many university scholarships and fellowships in the fields of physics, chemistry and related subjects are now being financed through industrial sources, and the establishment of this scholarship in the biological field is a most welcome one.

A Polarographic Discussion Panel, having as its objects the holding and the sponsoring of informal discussions on the subject of polarography as applied to chemical analysis, has been formed by the Physical Methods Group of the Society of Public Analysts and Other Analytical Chemists. Plans are in hand to arrange a first meeting in London during April. Particulars may be obtained from the honorary secretary, Mr. J. T. Stock, Chemistry Department, L.C.C. Norwood Technical Institute, Knight's Hill, London, S.E.27.

Major John A. Hunt asks us to state that inquiries in connexion with the report on the Survey of British Somaliland (see *Nature*, **158**, 511; 1946) should be addressed to the Secretary to the Government, Hargeisa, British Somaliland, via Aden; and not Burao as indicated in the bibliographic reference.

Erratum.—In the communication entitled "Constitution of Strychnine and its Relation to Cinchonine" by Sir Robert Robinson in *Nature* of February 22, p. 263, the bond from the quinoline nucleus should be attached to the 4-position and not to the 3-position as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Use of a Cyclotron to Detect Short-Period Activities

THE cyclotron at Cambridge has a high-frequency set which can be readily modulated, allowing information to be obtained on activities of period varying roughly from 100 microseconds to 1 second.

The apparatus (Fig. 1) consists of a master oscillator driving a ring-of-twelve scaling unit. Position 1 on this ring of twelve, operating through the modulator, turns on the radio-frequency voltage to the dees and delivers a burst of particles. Position 2 is a blank, and positions 3–12 connect the counter impulses, via a gating unit operated by the ring, to ten separate scales-of-four with separate mechanical recorders.

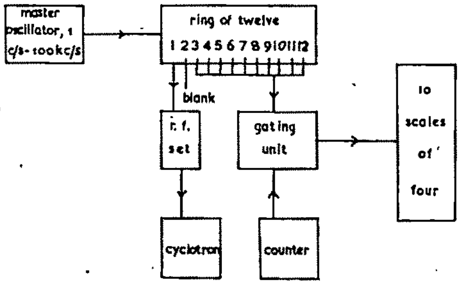

Fig. 1

To test this arrangement on a known reaction, the modulator time constants were adjusted to allow the master oscillator to run at 5 cycles per second, and the cyclotron output (for this experiment 5 MeV. protons, 70 microamp. beam current) was used to produce neutrons from a lithium target. Close to the target was placed a Geiger counter with a thin mica window outside which was a sheet of beryllium metal. The assembly was screened on all sides by about 1 in. thickness of lead. The Be($n\alpha$) reaction giving He^6 would be expected, and a period of about 0·8 sec. was found.

It was decided to check the period, and a sequence of forty-four short runs was made, each of 30 sec. duration. Between runs the apparatus was switched off to allow the background to decay to a predetermined figure—the time taken being 5–9 minutes. This background was found to be roughly proportional to the integrated number of neutrons in the 30 sec. run, and is probably due to neutron-induced activities in the brass wall of the counter, the period of 5 min. agreeing with one of the copper isotopes.

The results were:

Channel No.	3	4	5	6	7	8	9	10	11	12
Totals (each unit equals 4 β-particles)	433	368	347	286	265	233	215	198	177	157
Background of 57 subtracted	376	311	290	229	208	176	158	141	120	100

These (Fig. 2) show an exponential decay with channel number, giving a half-life of 4·74 channels, or 0·87 sec.

The errors in this determination are partly statistical (± 0·04), and partly arise from the determination of the background count. This was estimated by doing background measurements before and after particular runs, and also from another set of data using the proportionality mentioned above. The error is probably ± 10, which would change the period by about ± 0·04 sec. The final result is, therefore, 0·87 sec. ± 0·06, agreeing with other determinations.

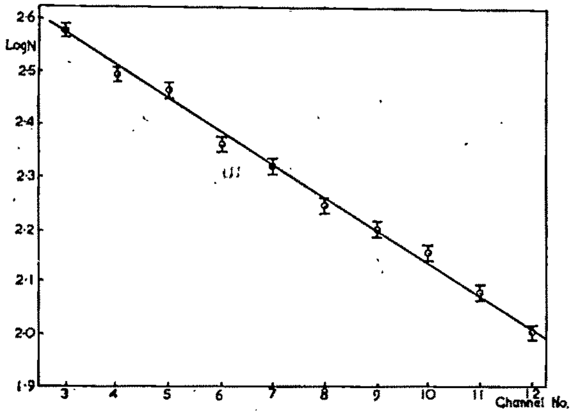

Fig. 2

One other observation of interest was made. The master oscillator was varied over the range 5 c./sec. to 6,000 c./sec. Apart from the He^6 period, the only effect observed was an increased counting-rate on the first two or three channels at the highest speed. This may well have been due to slow neutrons scattered from the screening tanks around the cyclotron. There were certainly no other periods from 10^{-3} sec. to 1 sec. of comparable cross-section to the Be($n\alpha$)He^6.

We should like to thank Mr. Kandiah's group for building the electronic apparatus for us.

J. M. CASSELS
R. LATHAM

Cavendish Laboratory,
Cambridge.
Jan. 20.

Presence of a Penetrating Component in Extensive Showers in the Atmosphere

THE existence of a penetrating component in extensive atmospheric showers has been investigated by several workers[1], using different methods. Results obtained with cloud-chambers[2] do not seem to justify a final conclusion. Cocconi and co-workers[3], using counters, decided in favour of the presence of meson showers simultaneous with extensive showers; more recently, Rogozinski[4], using counters driving neon lamps, concludes that mesons are probably associated with extensive showers.

We have undertaken an investigation using counters, so conducted that a greater number of criteria is available for distinguishing penetrating particles from the electrons and photons existing in the showers. This distinction was based upon the following properties of penetrating particles: (1) high penetrating power; (2) low multiplication probability while crossing thick iron or lead layers; (3) penetrating particles dissipate energy in a different way from high-energy photons and electrons, so that absorption varies differently as the atomic number of the absorbers is varied.

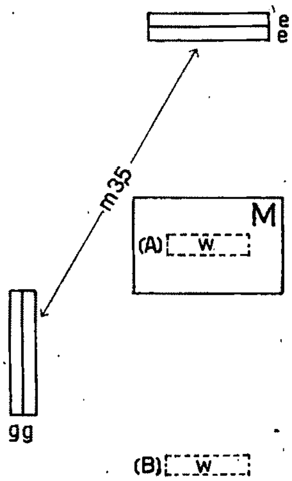

Fig. 1. EXPERIMENTAL OUTLAY (NOT TO SCALE)

Our experiments were carried out at a height of 2,100 m. above sea-level (at Lago d'Inferno, lat. 46° 01′ N., long. 9° 32′ E.) during the summer of 1946. The experimental arrangement is shown in Fig. 1. The counters to which the same identification letters are assigned are in parallel. Counters *e*, *f*, *g* in coincidence detect the presence of extensive showers. In Fig. 2, group *M* (selector) includes seven counters, of which twofold coincidences $a + b$ and fourfold coincidences $a + b + c + d$ were registered. Twofold coincidences which were not accompanied by fourfold coincidences were accounted for as being due to non-multiplying particles (such as mesons) crossing layers S_1 and S_2; fourfold coincidences as being due to high-energy photons and electrons, or to simultaneous arrival of several penetrating particles. The selector was arranged in accordance with Arley's[5] and Molière's[6] theoretical calculations on the multiplication and lateral spread of shower electrons.

Since we are interested in events coinciding with the extensive showers as detected by $e + f + g$, we measured the $a + b + e + f + g$ coincidences (referred to as V; the number of random coincidences, directly evaluated, was found to be less than 5 per cent of the effective ones), the $a + b + c + d + e + f + g$ coincidences (VII), and eventually we appraised the difference between them, V–VII. The table gives observed counting-rates per minute for different layers S_1 and S_2:

S_1 (cm.) 1	S_2 (cm.) 2	V/min. 3	VII/min. 4	$\frac{\text{V} - \text{VII}}{\text{min.}}$ 5	$\frac{\text{V} - \text{VII}}{\text{VII}}$ 6
5 Pb	1·6 Pb	$4{\cdot}0 \pm 0{\cdot}4 \times 10^{-2}$	$3{\cdot}3 \pm 0{\cdot}4 \times 10^{-2}$	$7{\cdot}7 \pm 1{\cdot}6 \times 10^{-3}$	0·2
5 ,,	5 ,,	$2{\cdot}7 \pm 0{\cdot}2 \times 10^{-2}$	$2{\cdot}2 \pm 0{\cdot}15 \times 10^{-2}$	$5{\cdot}2 \pm 0{\cdot}8 \times 10^{-3}$	0·2
10 ,,	5 ,,	$7{\cdot}9 \pm 0{\cdot}9 \times 10^{-3}$	$5{\cdot}3 \pm 0{\cdot}7 \times 10^{-3}$	$2{\cdot}6 \pm 0{\cdot}5 \times 10^{-3}$	0·5
15 ,,	5 ,,	$4{\cdot}3 \pm 0{\cdot}6 \times 10^{-3}$	$2{\cdot}5 \pm 0{\cdot}4 \times 10^{-3}$	$1{\cdot}8 \pm 0{\cdot}4 \times 10^{-3}$	0·7
18 Fe	5 ,,	$1{\cdot}2 \pm 0{\cdot}14 \times 10^{-2}$	$8{\cdot}8 \pm 1{\cdot}3 \times 10^{-3}$	$3{\cdot}4 \pm 0{\cdot}8 \times 10^{-3}$	—
36 ,,	5 ,,	$5{\cdot}9 \pm 0{\cdot}8 \times 10^{-3}$	$4{\cdot}5 \pm 0{\cdot}7 \times 10^{-3}$	$1{\cdot}4 \pm 0{\cdot}4 \times 10^{-3}$	—

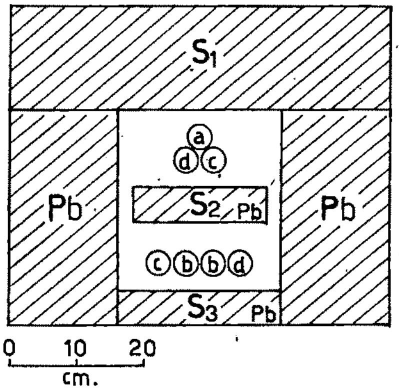

Fig. 2. VERTICAL CROSS-SECTION OF THE SELECTOR *M*

Consider the data obtained for lead (first four lines of the table). From columns 4 and 5, it appears that, as the thickness of the lead layer is increased, the frequency of VII coincidences decreases more quickly than the frequency of the V–VII coincidences. In column 6 the rate change of the ratio $\frac{\text{V–VII}}{\text{VII}}$ is separately shown for the sake of clearness. It is to be noted that, were coincidences V–VII due to shower electrons which originated twofold rather than fourfold coincidence in the selector system, the ratio $\frac{\text{V–VII}}{\text{VII}}$ should decrease or at most remain unchanged; in fact, the selector's efficiency increases as we increase the thickness of layers S_1 and S_2 [5,6].

The existence of V–VII events and their frequency-rate constitute, therefore, preliminary proof of the presence of penetrating particles in extensive showers. Further proof is given by our results with iron. The frequency-rates of coincidences V and, especially, of coincidences V–VII, for 18 cm. iron plus 5 cm. lead and 36 cm. iron + 5 cm. lead, are less than those found for 5 + 5 cm. and 10 + 5 cm. lead respectively, whereas these thicknesses of lead should be equivalent to the above-mentioned thicknesses of iron, were the coincidences only due to high-energy electrons or photons.

The absorption curve which may be deduced from column 5 shows that, whenever the penetrating component of extensive showers is due to mesons, these would have a spectrum of lower energies than those of mesons present in total radiation.

It should, however, be noted that some of the events due to penetrating particles may have accumulated in coincidences VII by the effect of secondary knock-on electrons, or owing to the simultaneous presence of several mesons.

During the measurements, about two hundred photographs were also taken in a cloud-chamber, in coincidence with the extensive showers detected by the counters. The chamber was operated in the two different positions *A* and *B* (see Fig. 1). In position *A* (chamber under the selector, $S_1 = S_2 = 5$ cm. lead, S_3 removed) no photographs were obtained which showed for certain more simultaneous mesons (meson showers); in the *B* position, photographs appear distinctly richer in tracks when the cloud-chamber is driven by VII coincidences than when it is driven by V–VII coincidences.

A detailed report of these measurements will be published elsewhere.

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Spread of Discharge in Geiger Counters

The important differences in the behaviour of slow and fast counters noticed by Trost[1] and others[2,3] have led several workers to investigate, in a preliminary manner, the factors which prevent the discharge, developed near the path of the incident primary particle, from spreading along a counter, or from one counter to another enclosed within the same envelope. The experiments of Stever[4], Wilkening and Kanne[5], Ramsey[6] and Curran and Strothers[7], and others are well known. Hill and Dunworth[8] have recently reported results on the velocity of discharge spread.

It appears to be implied in some of the earlier discharge-localization experiments[9] that, provided the interruption in the path of the discharge, whether it be a bead on the wire or a gap between two cathodes, etc., is of reasonable size, the discharge will very rarely, or never, spread in a fast (self-quenching) gas. Wilkening and Kanne[5] showed qualitatively that the discharge-spread in fast counters increased with decreasing concentration of quenching gas, etc.

We have recently re-investigated this matter with divided cathode counters similar to those used by Ramsey[6] and others, about 12 in. in length and containing six 2-in. or twelve 1-in. copper cathodes (Fig. 1). The cathodes were cleaned in acid and may be described, therefore, as unoxidized in the gross chemical sense. One of the extreme cathodes was irradiated with radium γ-rays using a carefully tested collimator system, and double coincidences between this cylinder and those farther down the tube, taken in turn, were measured. The intervening cylinders were operated at voltages just below their counting thresholds. Subsidiary experiments were made to assess the importance of random coincidences, the effect of which was shown to be negligible, and the usual counter tests were applied to the individual cylinders to check their behaviour. The plateaux even for the 1-in. long, ¾-in. diameter cathodes were satisfactory; they were ∼ 160 volts long with alcohol/argon, but were less with methane fillings. The main results were not thereby affected.

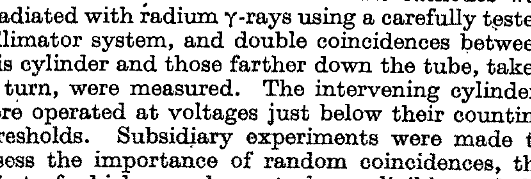

Fig. 1

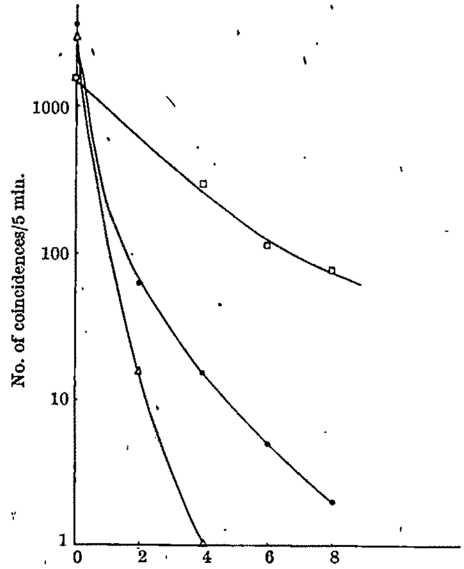

Fig. 2. △, 1·0 cm. Hg ethyl ether, 10 cm. Hg argon
□, 2·5 cm. „ methane, 7·5 cm. „ „
●, 0·4 cm. „ ethyl alcohol, 10 cm. „ „

Fig. 2 gives some typical results for fast counter fillings. Experiments with argon alone showed much greater discharge spread, namely, approximately 100 per cent even for 8-in. counter length; in this case it was necessary to use external quenching in order to obtain a satisfactory resolving time in the coincidence circuit. It is seen from Fig. 2 that localization is by no means complete, and even with 2 in. between the irradiated counter and its coincidence partner, roughly 1 per cent of the primary discharges caused spreading of the discharge. Similar results taken with a different experimental arrangement were obtained by Curran and Strothers[7].

It is scarcely possible to interpret these results without further work (now in progress); a particular point of interest is to decide whether the discharge spreads by virtue of (*a*) photo-ionization in the gas, or (*b*) through emission of photo-electrons at the cathodes; it is unlikely that the spread of discharge is caused by diffusion of electrons since the field in the intervening cathodes (Fig. 1) would remove them (see also Korff[9], p. 95). Some preliminary experiments we have made with another special counter lead to the tentative conclusion that the mechanism (*b*) above is the more important cause of discharge spread. The discharge invariably spread from the end counter to that next to it (⅛-in. gap) when they were used in coincidence, due presumably to field penetration. Coincidence counting was thus started with the first and third cylinders.

The results are of interest in that they show the presence of marked photon effects in fast counters. Similar results have been published previously[5], using a different and more qualitative method of presentation, but the absence (relative or total) of such effects, particularly those caused by relatively long wavelength photons, appears sometimes to be postulated without reason. The present results imply that photo-electrons are emitted more or less continuously from the cathode, or gas in the counter near it, during the early part of pulse formation in a fast counter, that is, so long as photons are being produced. The basic conclusion, due to Korff, that in fast counters the positive-ion sheath causes no secondary emission on arrival at the cathode, is, of course, unaffected by the above results.

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Stability Constants of Internal Complexes

Apart from the results of a series of studies dealing with complexes of copper, little is known of the stability of internal complexes. Calvin and his collaborators[1] have found wide variation in the stability of complexes of copper formed from a series of β diketones and *o*-hydroxy-aromatic aldehydes. It is a matter of interest to determine whether a similar wide variation of stability occurs with complexes formed by the co-ordination of a series of metals with one chelating molecule. For this reason and also because stability constants may eventually help to throw some light on the inactivation of essential trace metals in biological systems[2], we have begun an investigation of complexes formed by a variety of metals.

Working in the first instance with 50 per cent water – 50 per cent dioxane solutions and using substantially the method employed by Calvin and Wilson[1], we have obtained the following values (see Table 1) for the stability constants of complexes formed by a series of bivalent metal ions with salicylaldehyde. The reactions involved are

$$Me^{++} + K\bar{e} \rightarrow MeKe^{+}$$
$$MeKe^{+} + K\bar{e} \rightarrow MeKe_2,$$

where $K\bar{e}$ represents the bidentate chelate minus a hydrogen ion. K_1 and K_2, the equilibrium constants for the two successive steps, are related to K_{av} as follows:

$$(K_{av})^2 = K_1.K_2 = \frac{[MeKe_2]}{[Me^{++}][K\bar{e}]^2}.$$

Table 1

Metal	Radius of metal*	Log K_1	Log K_2	Log K_{av}
Pd	1·32 A.	7·74	7·03	7·39
Cu	1·32	7·40	5·91	6·65
Ni	1·39	5·22	3·97	4·59
Pb	1·46	5·06	4·04	4·55
Co	1·32	4·67	3·63	4·15
Zn	1·31	4·50	3·60	4·05
Cd	1·48	4·62	3·14	3·88
Mg	1·40	3·69	3·11	3·40

* The values quoted in this column are tetrahedral or square covalent radii taken from "The Nature of the Chemical Bond" by L. Pauling (Cornell Univ. Press, 1939).

Preliminary work with other chelating substances such as glycine and oxine shows that the stability constants of the metal complexes fall in much the same order as with salicylaldehyde, except that occasionally the position of neighbouring metals is reversed. Not enough types of chelate molecules have yet been studied to say whether this similarity of order is general. Attempts to obtain values of K_{av} for salicylaldehyde complexes in water by a process of extrapolation, using values obtained with water–dioxane mixtures containing progressively less than 50 per cent dioxane, were not satisfactory owing to the fact that even in mixtures containing as little as 10 per cent dioxane the solubility was too low. However, by using acetylacetone as the chelating substance, it was found practicable to work with water solutions and thus to observe the effect of change of solvent on the magnitude of K_1, K_2 and K_{av}. The following values were obtained for nickel acetylacetone in different solvents.

Table 2

Solvent	K_1	K_2	K_{av}
50% dioxane	6·82	5·24	6·03
20% "	6·12	4·79	5·46
Water	5·92	4·57	5·25

It is not yet clear what factor or factors determine the order of the metals in Table 1. Electronegativity of the metal might be expected to play some part. If this were so and if electronegativity is accurately defined by the relation recently deduced by Gordy[3], we should expect to find a correlation between the covalent radii of bivalent metals and the stability of the complexes formed by them. From Table 1 it can be seen that there is no simple relation between these two constants.

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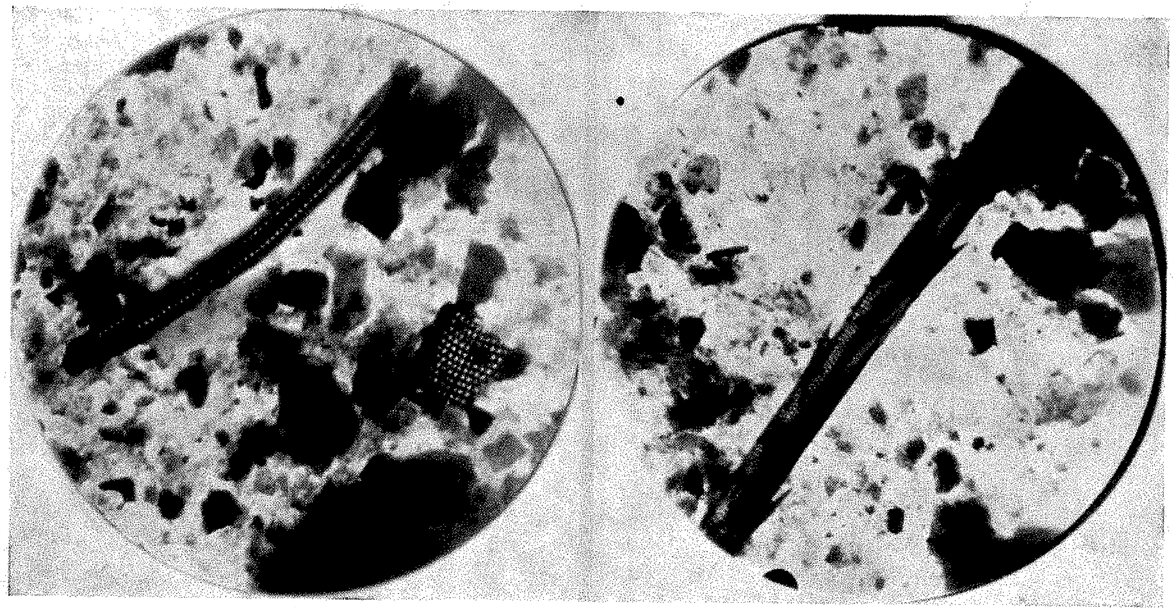
Preparation of Thin Specimen Films

A film of cellulose nitrate or a similar material is laid on a water surface and transferred to a specimen holder. A very thin layer of beryllium or aluminium is then deposited on the film from the vapour phase, after which the cellulose nitrate is dissolved away. Only the metal film then remains, and its lack of visible structure can be checked by photographing in the electron microscope. The durability and resistance of the layer to chemical attack are very high. A matter of great importance in the study of specimens in which completely opaque particles occur on the film is that the metal film readily conducts away absorbed energy. With such particles, however, films of cellulose acetate or similar materials are very easily broken. Beryllium and aluminium films of as little as 20 A. thickness (diameter 100 μ), and also aluminium films 12 A. in thickness, have been prepared by this procedure.

Because of the absorption being slight in this film, it is possible to make a closer study of minute

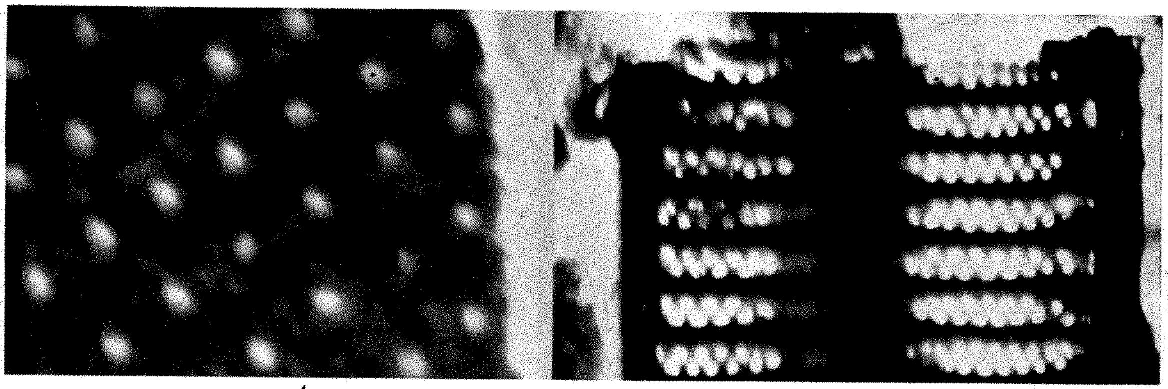


A *B*

Fig. 1

A. A worm-like diatom the cross-sectional diameter of which does not exceed 1/1,500 mm. The photograph also shows shell fragments. × 6,000

B. Diatom with a very fine skeleton structure. At some distance, but connected with the structure, are some sharp thorns, possibly a means of self-defence. × 5,500



A *B*

Fig. 2

A. A detail from the structure of a diatom shell. As can be seen, the holes are located in a very regular manner. × 90,000

B. A beautifully branched minute fine structure. × 28,000

structures, such as large molecules, and their shape.

With the aid of such resistant metal films, it is possible, by taking series of photographs, to follow the reactions of one and the same particle of a substance when subjected to different chemical treatments. It is not difficult to number the holes on the preparation holder in such a way that any given hole can be easily located.

Observation of Diatoms. The method described elsewhere (see p. 354 of this issue of *Nature*) for the investigation of the structure of clay can also be employed with advantage for the study of diatoms. Several photographs of diatoms have been taken in connexion with studies on post-glacial clays. It is found that diatoms lying in the clay surface accompany the cellulose acetate film when it is drawn away. Since the cellulose nitrate encloses the diatoms within an envelope of sufficient strength, they can readily be removed from the clay. Even diatoms of extremely fine structure or of great fragility can be loosened and transferred to an aluminium or beryllium film for observation in the electron microscope. In cases where the diatoms consist of adjacent fragments, they also can be studied in the microscope with their original relative positions in the clay undisturbed, which has hitherto been impossible.

The high resolving power of the electron microscope employed makes it possible to study diatoms of submicroscopic size. Diatoms have thus been seen which have hitherto been unobservable on account of their minute dimensions. Of interest is the detailed study of the structure of the diatoms, especially the structure of the shells, which is sometimes so fine that magnifications of more than 100,000 are necessary to disclose it.

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Ion Exchange Resins as Catalysts

Ion exchange resins, in the hydrogen form, appear to offer several advantages as acid catalysts, such as the possibility of their continuous or repeated use without renewal, and their easy removal, by decantation or otherwise, from the reaction mixture. A paper on the subject has now been published by Sussman[1], who reports several examples of the successful use of 'Zeo-Karb' in esterification, alcohol dehydration and other acid-catalysed processes. Sussman was less successful with ester hydrolysis, and attributes this to the poor contact attainable in the three-phase system ester–water–catalyst.

We have examined the hydrolysis of some esters, using 'Amberlite IR-100' as catalyst; this is a synthetic resin containing one equivalent of strong (sulphonic) acid groups in approximately 500 gm. of resin. 1–4 gm. of resin were used per 100 ml. of liquid, the mixture being agitated in a thermostat at 25° C. Methyl and ethyl acetates, both in aqueous solution, underwent hydrolysis according to first-order reaction equations, whereas with *n*-butyl and benzyl acetates the reaction was of zero order so long as ester was present as a separate phase. If we assume in these latter cases that the reaction occurs in the saturated aqueous phase, we may compare our rates with those previously reported[2] for the same reactions catalysed by hydrochloric acid. Regarding the 'Amberlite' as a strong acid of equivalent weight 500, we find that the heterogeneous catalyst is the more efficient of the two, by factors of 1·7 for methyl acetate, 2·3 for ethyl acetate and 9·8 for butyl acetate.

We think that these results illustrate the importance of adsorption in resin-catalysed reactions; in general, reaction-rates will be governed not only by solubilities but also by the relative adsorptions of reactant, product and solvent molecules at the resin surface.

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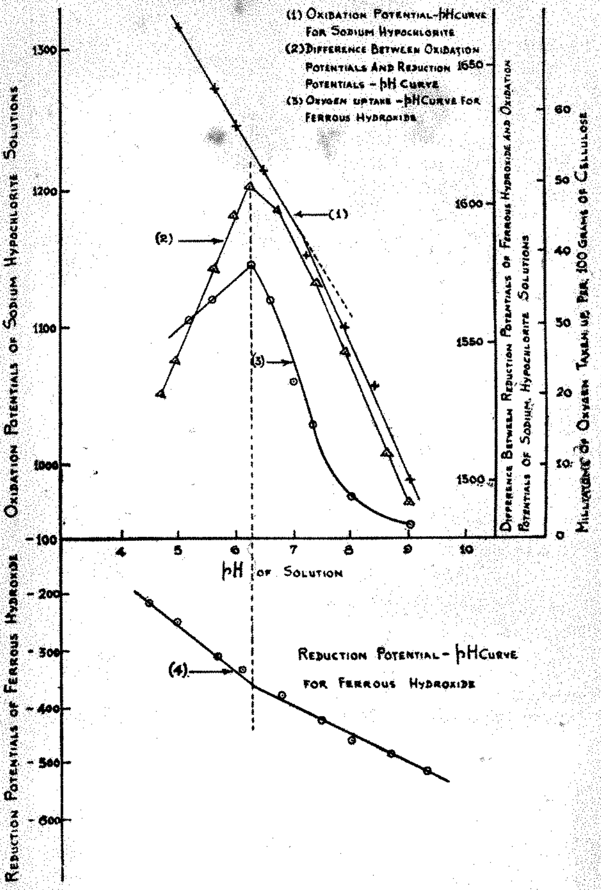
Reduction Potentials of Ferrous Hydroxide

The accelerated oxidation of cellulose in the presence of ferrous hydroxide by dilute solutions of sodium hypochlorite, buffered to different hydrogen ion concentrations, has been studied by Nabar and Turner[1]. It was shown that the maximum absorption of oxygen and the maximum attack on cellulose occurred at about *p*H 6·4. From similar earlier investigations, with leuco vat dyes as accelerators, Nabar, Scholefield and Turner[2,3] had shown that the maximum oxygen uptake and the maximum oxidation of cellulose occurred at about *p*H 7·4. The obvious dependence of the oxidizing intensity of sodium hypochlorite solutions on the specific substance present on cellulose may be attributed to the differences in their physico-chemical properties, such as reduction potentials, ease of oxidation, etc. The present work was undertaken to study the reduction potential of ferrous hydroxide and examine its influence on the oxidation mechanism.



A few attempts[4,5] have been made to measure the reduction potentials of ferrous hydroxide; but values proposed by different investigators show considerable variation. The problem under investigation was to determine the reduction potentials of ferrous hydroxide in dispersed condition on cellulose, since the activation of oxidation has been found to occur when cellulose is impregnated with the ferrous hydroxide. The following procedure was finally evolved and adopted for the measurement of the potentials.

Ferrous hydroxide was precipitated on loose cotton tightly wrapped around a platinum wire sealed in a glass tube. The impregnated cotton was washed in air-free distilled water, and the electrode was immediately immersed in a specially designed flask containing an air-free buffer solution of known hydrogen ion concentration through which hydrogen was being rigorously bubbled. With saturated calomel half-cell as the reference electrode, the E.M.F. of the following cell was measured at regular intervals:

$$\underset{+}{\mathrm{Hg}} \mid \mathrm{Hg_2Cl_2}, \text{ Sat. KCl.} \parallel \text{Sat. KCl} \parallel \begin{array}{l}\text{Ferrous hy-}\\ \text{droxide on}\\ \text{cotton in}\\ \text{buffer solu-}\\ \text{tion.}\end{array} \mid \underset{-}{\mathrm{Pt}}$$

The E.M.F. reached a constant value after about fifteen minutes and remained steady for two to four hours. This value was taken as the E.M.F. of the cell referred to above. The oxidation potential of sodium hypochlorite was measured as described by Nabar, Scholefield and Turner[3]. Measurements of oxygen uptake by cotton impregnated with ferrous hydroxide were carried out simultaneously. All measurements were made at 30° C. The results are illustrated in the accompanying graphs.

Curve 1 shows the relation between the *p*H of sodium hypochlorite solutions and the oxidation potentials. Curve 4 shows the relation between the *p*H and the reduction potentials of ferrous hydroxide on cotton. The relation of the difference between the oxidation potentials of sodium hypochlorite to the reduction potentials of ferrous hydroxide and the *p*H is shown in curve 2, and the relation between oxygen uptake by cotton impregnated with ferrous hydroxide and the *p*H of hypochlorite solution is shown in Curve 3. It is interesting to see the close resemblance in the shape of curves 2 and 3, and the coincidence of the *p*H for maximum oxygen uptake and the *p*H for the maximum difference in the potentials with the break in the *p*H-reduction potential curve. The results will be discussed in detail elsewhere.

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Inhibition of Catechol Bacteriostasis by Molybdates

Large areas in and near Somerset are unsuitable for grazing because they cause severe diarrhœa in cattle. These areas, called 'teart', are found on the argillaceous Lower Lias. The disease has been shown[1] to be due to an excess of soluble molybdates in the herbage and the soil; it can be cured by adding copper salts to the diet. A possible explanation of the effect of molybdates is suggested by the following observations.

Molybdates form red complexes with catechols[2,3]. These are not very stable, and we have found that the colour disappears on warming, or on shaking with ether to remove catechol. Now it is likely (though unproved) that catechols occur in the intestine of ruminants, because they are present in many fodder plants[4] and because the tyrosine of proteins is converted by intestinal bacteria to phenol[5] which, in the presence of suitable plant[6] or animal[7] oxidases, is oxidized to catechol.

Catechol, like other phenols, is bacteriostatic, but might be less so in the presence of molybdate owing to the formation of the complex. We have found that, in fact, potassium molybdate does reduce the bacteriostatic action of catechol when added in concentrations which by themselves have no effect on the bacteria. In a serial dilution test at 25° C., a catechol concentration of *M*/1280 was needed to inhibit the growth of *Staphylococcus aureus*: when half a mole of potassium molybdate was added per mole of catechol, the concentration of catechol needed to inhibit growth was raised to *M*/160. Even *M*/20 potassium molybdate was without effect on *S. aureus*. With *Escherichia coli* similar results were found; the minimum bacteriostatic concentration of catechol was raised from *M*/160 to *M*/40 by adding half a mole of potassium molybdate per mole of catechol used.

Phenol, *o*-cresol and resorcinol form no coloured complexes with potassium molybdate; correspondingly, we found that it had no effect on their minimum bacteriostatic concentrations.

These biological results suggested that a complex, $K_2MoO_4.2C_6H_6O_2$, was formed, and a colorimetric experiment was made at 25° C. to test this theory.

Molarity in aqueous solution		Colour intensity in arbitrary units
Potassium molybdate	Catechol	
0·06	0·02	1·00
0·533	0·0266	1·29
0·04	0·04	1·84
0·0266	0·0533	2·27
0·02	0·06	1·77

The total molarity of solute is kept constant, and the colour intensity, and hence presumably the concentration of the complex, is a maximum at a proportion equivalent to $K_2MoO_4.2C_6H_6O_2$.

These facts are compatible with the theory that the activity of bacteria in the normal intestine is controlled by catechols: that molybdates reduce the effective concentration of catechols by forming complexes: and that with the removal of the control, bacterial activity becomes excessive and causes diarrhœa. It is realized that further investigation would be needed to confirm this theory; in particular, the effect of copper as an antidote still requires explanation.

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I am grateful to Messrs. McGowan and Brian for allowing me to read their letter and to add my comments. Some data obtained in 1943, when working in the Unit of Animal Physiology at Cambridge, are of interest in connexion with their observations. It was found that fresh aqueous plant extracts give a colour reaction when molybdate is added. This reaction is due to the presence of substances, usually classified as 'tannins', which contain vicinal phenolic hydroxyl groups. Fresh grass cuttings were fed for two days to a rumen-fistula sheep; the rumen contents were then removed through the fistula. An extract of the ingesta thus obtained gave a colour reaction characteristic of catechols, with both ammonium molybdate and ferric chloride. This shows that the reaction between molybdate and catechols suggested by McGowan and Brian does, in fact, occur. Their explanation still remains to be tested by experiments on animals, but the readiness of molybdates to form organic complexes must be an important factor in the etiology of molybdate poisoning in cattle.

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Succinic Dehydrogenase in Protozoa

THERE is, as yet, relatively little information about the occurrence of individual enzymes in Protozoa. We have been successful in demonstrating the presence of a succinic dehydrogenase in homogenates of *Paramecium caudatum*. This has been done using a modified Cartesian diver respirometer of macro dimensions (40–60 μl. total volume).

Three-day cultures were concentrated and freed from bacteria by a process of electrically directed migration followed by centrifugation. Cell-structure in the suspension ($2–6 \times 10^4$ organisms/ml.) was destroyed by grinding for two minutes between ground-glass surfaces at 0° C. The resulting homogenate was brought to *p*H 7·2 with phosphate buffer and its oxygen uptake in the presence of succinic acid, methylene blue, and inhibitors was studied. The final concentrations used were: succinate, 0·05 *M*; methylene blue, 0·5 mgm./ml.; phosphate buffer, 0·03 *M*; malonate, 0·08 *M*; cyanide and azide, 0·01 *M*; The *Q*'s (μl. oxygen/10^4 organisms/hour) are set out in Table 1.

TABLE 1

	Q
Homogenate	1·9
„ + succinate	4·3
„ + „ + KCN	1·8
„ + „ + NaN_3	2·0
„ + „ + methylene blue	6·0
„ + „ + „ „ + KCN	4·8
„ + „ + „ „ + malonate	2·0

These results show that succinate doubles the endogenous oxygen uptake, and that cyanide or azide abolishes this increase. In the presence of succinate, methylene blue produces a further increase, and is able to offset the cyanide inhibition. Malonate completely abolishes the increase of oxygen uptake which is caused by succinate.

For comparison, Table 2 shows the effect of some of these factors on the endogenous respiration.

TABLE 2

	Q
Homogenate	1·9
„ + KCN	0·8
„ + NaN_3	1·1
„ + methylene blue	1·9

From these tables it follows that cyanide inhibits the endogenous respiration by 56 per cent and the extra respiration due to succinate by 58 per cent. The corresponding figures for azide are 44 and 63 per cent. Failure of methylene blue to stimulate the endogenous respiration of the homogenate may indicate lack of substrate, or, conversely, a sufficient supply of carriers, in the original system.

While indicating that *P. caudatum* contains a succinic dehydrogenase essentially similar to that found in the Metazoa, the results have direct bearing on the question of cyanide-stability of respiration often reported in Protozoa, and should be interpreted in the light of the occurrence of cytochrome oxidase[1].

The investigation will be published in full elsewhere.

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Dec. 16.

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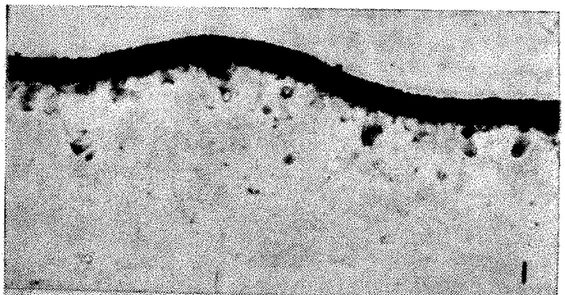
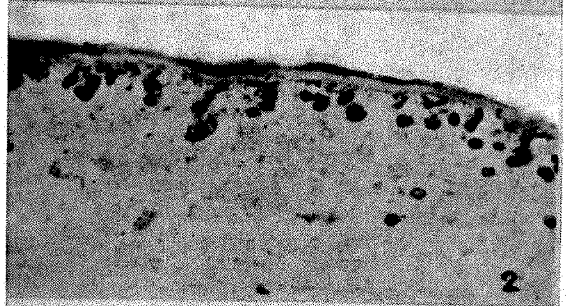
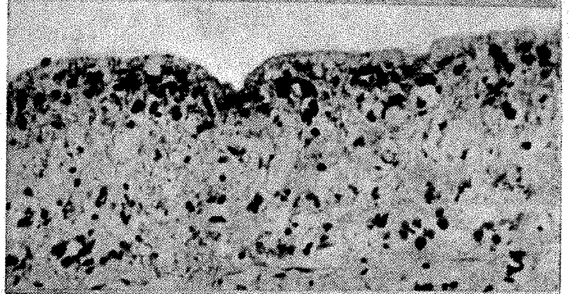
[1] Boell, *Proc. U.S. Nat. Acad. Sci.*, **31**, 396 (1945).

Histological Distribution of Alkaline Phosphatase in Helminth Parasites

THE organisms used in this investigation were *Ascaris lumbricoides*, from the small intestine of the pig, and *Moniezia expansa*, from the small intestine of the sheep. They were brought to the laboratory in host gut contents contained in vacuum flasks and were fixed within two hours of the time of their removal from the host. The histological distribution







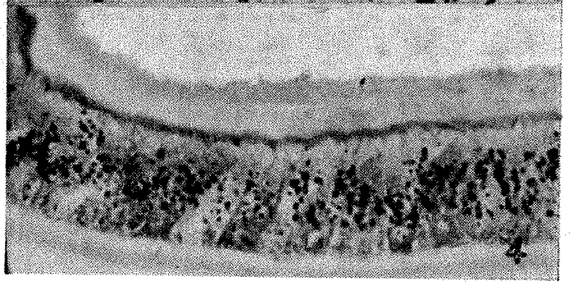


Fig. 1. CUTICULAR REGION IN A TRANSVERSE SECTION OF A MATURE PROGLOTTID OF *Moniezia expansa* (× 400) STAINED FOR ALKALINE PHOSPHATASE. NOTE THE STRONG REACTION IN THE CUTICULAR REGION

Fig. 2. CUTICULAR REGION IN A TRANSVERSE SECTION OF A MATURE SEGMENT OF *Moniezia expansa* (× 400) STAINED WITH HÆMATOXYLIN-EOSIN BY THE USUAL METHODS

Fig. 3. CUTICULAR REGION IN A TRANSVERSE SECTION OF THE SCOLEX OF *Moniezia expansa* (× 400) STAINED FOR ALKALINE PHOSPHATASE. THE THICK 'CUTICLE' IS ABSENT AND THE PHOSPHATASE REACTION WAS NEGATIVE

Fig. 4. INTESTINE IN A TRANSVERSE SECTION OF *Ascaris lumbricoides* (× 400) TAKEN FROM ABOUT THE MID-POINT OF THE PARASITE. THE SECTION WAS STAINED FOR ALKALINE PHOSPHATASE, THE SMALL BLACK BODIES IN THE INTESTINAL CELLS INDICATING THE POSITIVE REACTION

of alkaline phosphatase was determined by the method of Gomori[1], using sodium glycerophosphate as a substrate.

The enzyme appeared to be present on or in the cuticle of mature segments of the cestode in considerable amounts (Fig. 1). In sections stained by the usual methods with hæmatoxylin-eosin, this cuticular region stained a dark blue colour (Fig. 2). Only a very faint brown deposit could be seen on the extreme outside edge of the cuticle after incubating sections in the absence of substrate and staining by either the cobalt nitrate or silver nitrate methods. When this 'cuticle' was absent as in young proglottids, no phosphatase reaction was obtained (Fig. 3). Apart from that in the cuticular region, the enzyme was found only in tissues surrounding developing eggs, and then only in small amounts.

Small spherical bodies in the intestinal cells of the nematode *Ascaris lumbricoides* gave a phosphatase reaction (Fig. 4). No other tissues of the parasite gave a positive reaction.

Chandler[2] has shown that certain tapeworms are dependent on host *dietary* carbohydrate for development. This would indicate that the parasites concerned obtained their carbohydrate from the intestinal contents of their host, implying that absorption took place through the parasite body surface. Glucose is absorbed from the intestinal contents of *Ascaris lumbricoides*[3]. It would appear then that the helminth parasites examined showed greatest concentrations of alkaline phosphatase in those regions which are associated with the absorption of carbohydrate. This finding is, therefore, in accordance with the hypothesis concerning the phosphorylation mechanism of absorption of glucose in the intestine and kidney[4,5].

I wish to acknowledge the assistance given by Mr. L. Turk.

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Jan. 6.

[1] *Proc. Soc. Exp. Biol. Med.*, **42**, 23 (1939).

[2] *Amer. J. Hyg.*, **37**, 121 (1943).

[3] Rogers, unpublished work.

[4] *Biochem. Z.*, **264**, 209 (1933).

[5] *Biochem. Z.*, **276**, 17 (1935).

Co-existence of Two Different Esterases in Liver Juice

WE have recently reported[1] the inhibition of the esterases contained, *inter alia*, in glycerol extracts of pancreatin and in liver juice by emulsifying the substrates employed (methyl butyrate, ethyl butyrate and ethyl propionate) with gum arabic. The cleavage of glycerides such as monobutyrine or olive oil, however, was not inhibited by this emulsification procedure. We therefore concluded that there are virtually two enzymatic systems present in these extracts, namely, a lipase splitting the esters of glycerols, and an esterase cleaving esters, where glycerol is replaced by lower alcohols.

Meanwhile, the observation was made that a further subdivision of the esterase system both in respect of pancreatic and liver extracts is possible, if the above-mentioned aliphatic ester compounds are being replaced by esters consisting of at least one aromatic constituent such as in ethyl benzoate. The cleavability of ethyl benzoate is not inhibited by emulsification with gum arabic, contrary to the findings with esters consisting of an aliphatic alcohol and an aliphatic acid.

The question whether there is a separate 'salolase' in liver juice or in pancreatic extracts concerned with the splitting of aromatic esters has been widely discussed without arriving hitherto at any definite conclusion[2]. Recently, I. S. Falconer and D. B. Taylor reported the isolation from liver juice of an enzyme precipitate of esterase 10–15 times purer than whole liver[3]. They arrive at the conclusion that their preparation is not identical with the purified esterase prepared by E. Baman and co-workers, on the grounds of the different solubilities of the precipitable materials, and conclude: "It therefore appears that there are two liver esterases which we will refer to in order of their solubility as liveresterases I and II until a more satisfactory basis is found for their characterisation".

Without excluding the possibility that the esterase system of liver might be composed of more than two components, it would be worth while to investigate whether there exists a correlation between our two esterases (one of which is not inhibited by gum arabic) and Falconer and Taylor's esterase I and II.

Our method of emulsification, which is an improvement on that formerly used, is as follows. 2 millimoles of each ester (stored permanently in a refrigerator at 2° C.) are mixed in a small porcelain mortar with half their weight of recrystallized commercial gum arabic, and are vigorously ground for approximately 5 sec. 0·5 ml. amounts of phosphate buffer solution (*p*H 7) are then added from a burette at intervals of 10–15 sec. (temperature of buffer solution, 15° C.). Following the addition of each portion of buffer, the mixture is again vigorously ground. After 5 ml. have thus been introduced, the mixture is quantitatively transferred to a conical incubation flask of 50 ml. capacity with a 20 ml. mark. Small portions of buffer are used to rinse the sides of the mortar before the mixture is transferred to the flask, which is filled up with buffer to 20 ml.; 2 ml. of beef liver juice (diluted with three parts of distilled water) and 5 ml. samples are taken for titration at intervals of 0, 20, 40 and 80 min. When pancreatic glycerol extracts are employed, 6 ml. of a glycerol extract (diluted with two parts of buffer solution) are added, and samples are taken at intervals of 0, 45, 105, 165 and 225 min. The inhibitory effect thus obtained ranges from 65 per cent to 100 per cent, depending upon the ester and the sample of enzyme preparation. (The strongest inhibition is obtained with methyl butyrate emulsion if cleaved by pancreatic esterase. Tests carried out with one and the same sample were fairly constant; however, the amount of inhibition suffered by different enzyme preparations was found to vary by about 20 per cent. Cleavage of the esters in the absence of gum arabic was not subject to fluctuations.)

Provided that esterase I and II are separable from each other, I suggest that they should be tested as to their behaviour towards the emulsions of aromatic and aliphatic esters; for example, methyl butyrate and ethyl benzoate.

The objection might be raised that our esterases from beef liver extracts are not necessarily identical with those obtained from pig liver. Unfortunately, it is impossible in Palestine to obtain fresh pig liver at regular intervals. Since, however, this inhibitory effect is very general and has been observed in extracts prepared from living material covering nearly the whole range of biology (pig pancreas, beef liver, different organs of the honey bee, worker maggots of the honey bee, grasshopper's eggs, *Aspergillus niger*, *Penicillium Rocheforti*, *Bac. pyocyaneus*), it seems scarcely probable that pig liver juice should differ from beef liver juice in this respect.

A detailed account of our investigation will be given elsewhere.

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Jan. 19.

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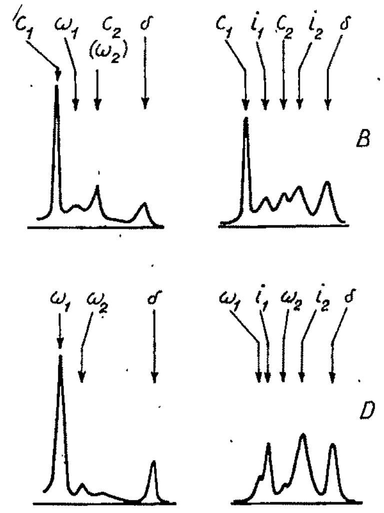
[1] Fodor, P. J., *Nature*, 158, 375 (1946). A detailed report is in the press.

[2] Oppenheimer, C., *Die Fermente*, 1st Supp., 38 (Junk, den Haag, 1936).

[3] Falconer, I. S., and Taylor, D. B., *Biochem. J.*, 40, 831 (1946).

Changes in the Electrophoretic Pattern of Cow's Milk during Early Lactation

DIFFERENCES in composition of colostrum and milk are well known, but with few exceptions have not been thoroughly studied by modern physico-chemical methods. During investigations of milk proteins which are to be published elsewhere, I have also studied samples of colostrum, and milk and whey recovered from these samples in the electrophoresis apparatus of Tiselius. All experiments were carried out in phosphate buffer at *p*H 7·7 and ionic strength 0·1. The diagrams reproduced are from the positive, ascending side of the apparatus. The samples were taken from cow's milk given on the day of delivery and 1, 3, 7 and 37 days thereafter.



In an electrophoresis diagram of milk (*A*), there are two main peaks, c_1 and c_2, corresponding to caseins, and a small one, w_1, corresponding to lactalbumin and lactoglobulin of the whey. (Another peak of whey protein, w_2, is overlapped by c_2.) In experiments with colostrum, diagrams are obtained (*B*) which are quite different from those with ordinary milk. The main difference is the presence of two new peaks, i_1 and i_2, in the case of colostrum. Of these, i_1 is evidently overlapping w_1. During the following days these decrease and the casein fractions come to dominate the diagram. After seven days there is only a very small difference, in comparison with the ordinary milk diagram.

Since the difference between colostrum and milk depends chiefly upon differences of the whey-forming components, whey has been prepared from the milk samples and investigated in the same manner. Diagrams of colostrum whey (*D*) are entirely different from those of ordinary whey (*C*). In the first case, the w_1- and w_2-peaks are very small, and two new peaks, i_1 and i_2, dominate the diagram. The slowest moving of them has been observed by Smith[1] and called 'immunoglobulin'. During succeeding days the picture changes rapidly (*C*), the w_1- and w_2-peaks increasing and the i_1- and i_2-peaks decreasing. As early as one day after delivery the shape of the diagram is markedly changed in this direction. After seven days it is the same as for ordinary whey. Mobility figures for components mentioned are collected in the accompanying table.

Samples investigated	Mobilities of different peaks × 10^5 cm.^{2} volt^{-1} sec.$^{-1}$				
	c_1	w_1	i_1	c_2 and w_2	i_2
Colostrum (*B*)	7·5	—	5·3	4·4	2·1
Whey from colostrum (*D*)	—	(6·6)	5·6	(4·2)	2·0
Milk seven days after delivery (*A*)	7·6	6·7	—	3·8	—
Whey from milk seven or thirty-seven days after delivery (*C*)	—	6·4	—	4·4	—

Thus the difference in protein composition between milk and colostrum is not due simply to an increased proportion of the whey components. Marked qualitative changes in the whey proteins also occur. These changes, as well as the increased protein content, are rapidly transient.

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[1] Smith, E. L., *J. Biol. Chem.*, 164, 345, and 165, 665 (1946).

Effect of the Source of Nitrogen in the Medium on the Formation of Penicillin by Surface Cultures of *Penicillium notatum*

A FRACTION which is active in stimulating penicillin formation may be prepared from aqueous extracts of seed peas either dried or green by means of ethanol precipitation[1].

The active ethanol-insoluble fraction, however, must be used at the correct dry matter concentration if consistent yields are to be obtained[2]. Using as a basis the idea that a definite amount of substance must be present in the medium, we tested first the effect on penicillin formation of a number of compounds which either had been isolated from, or might be postulated as occurring in, pea extracts.

Since then we have tested for their effect in stimulating penicillin formation a number of nitrogen-containing chemical compounds which could not be regarded as existing in vegetable extracts.

The results obtained indicate that penicillin formation may be stimulated by diverse chemical compounds.

A basal medium containing 0·3 per cent $NaNO_3$, 0·05 per cent KH_2PO_4, 0·025 per cent $MgSO_4.7H_2O$, 1 per cent NaCl and 3 per cent lactose was made up, and to this the compound under test was added so

TABLE 1

Mould growth as wet weight of mycelium in gm., penicillin formation (units/c.c.) and *p*H developed after 8 days in 40 c.c. medium containing basal constituents, 1·5 per cent glucose and compound under test in amount equivalent to 56 mgm. of nitrogen

Compound	Wet weight of mycelium (gm.)	*p*H	Titre units/c.c.
dl-Norleucine	0·87	7·4	100
l(−)-Leucine	3·14	8·3	240
l(−)-Tyrosine	2·5	7·9	225
l(+)-Cysteine	1·2	6·3	200
Triethylamine	0·88	6·4	160
Uric acid	1·67	6·3	160
Allantoin	1·88	5·3	100
Uracil	1·34	6·5	180
Sodium nitrate	0·60	7·3	150
Potassium nitrate	0·85	7·4	200
Nicotinic acid	1·04	5·4	200
Gelatin	2·0	8·1	190

that the nitrogen content was 56 mgm./40 c.c. medium (that is, 140 mgm. per cent).

The initial *p*H of the medium was adjusted in all cases to 5·6.

Since, when the active fraction from peas was used at its most stimulating concentration, 1·5 gm. per cent of glucose (or its carbohydrate equivalent) was present, this concentration of glucose was added to each compound under test.

In the experiments described *Penicillium notatum* 1249.B21 in surface culture was used, but preliminary experiments with submerged aerated cultures show that similar results may be obtained.

The wet weight of mycelium has been used as a measure of mould growth.

Representative results with various nitrogen-containing compounds are shown in Table 1. Low yields were obtained with the following amino-acids and other nitrogenous compounds: *dl*-tyrosine, *dl*-serine, *l*(−)-cystine, *dl*-aspartic acid, *l*(+)-glutamic acid, *l*(+)-arginine, *l*(+)-histidine, *dl*-tryptophan, *l*(−)-proline, asparagine, trimethylamine hydrochloride, diethylamine hydrochloride, hypoxanthine and potassium thiocyanate. The following nitrogenous compounds had no stimulating effect on penicillin formation although growth in their presence was good: glycine, *dl*-alanine, *dl*-valine, *d*-isoleucine, *dl*-phenylalanine, *l*-dihydroxy-phenylalanine, *dl*-methionine, *dl*-lysine, urea, *n*-propylamine and choline.

The results show that a wide variety of nitrogen-containing compounds has an effect in stimulating penicillin formation, and we cannot relate this stimulating effect to the presence of any definite chemical group in the substances tested.

It will be seen that gelatin forms a good basis for a synthetic medium. Using gelatin as a source of nitrogen, sources of carbon other than glucose have been tested. Typical results are shown in Table 2.

TABLE 2

Mould growth, penicillin formation and *p*H developed after 8 days, in 40 c.c. of medium containing basal constituents, gelatin to give a nitrogen content of 56 mgm., and carbon-containing compounds under test to give a concentration in the medium of 0·6 gm. (that is, 1·5 gm. per cent)

Compound	Wet weight of mycelium (gm.)	*p*H	Titre units/c.c.
Xylose	3·11	7·9	150
Glucose	2·0	8·1	190
Sorbose	1·5	7·9	150
Maltose	2·06	7·9	150
Trehalose	2·03	8·5	260
Raffinose	1·85	8·0	150
Inulin	1·98	7·9	240
Adonitol	1·61	7·7	260
Methyl alcohol	0·66	7·2	0
Ethyl alcohol	1·57	7·8	25
Sodium acetate	0·43	8·8	0
Ethyl acetate	0·46	5·0	0

The results show that when good growth did occur there was marked stimulation of penicillin formation, and that a variety of carbon-containing compounds could be used.

As with the active fraction prepared from peas, the concentration of sodium chloride in the synthetic media had a marked effect in stimulating penicillin formation, as will be seen in Table 3.

TABLE 3

The effect of the concentration of sodium chloride on penicillin formation in the basal medium containing gelatin equivalent to 56 mgm. of nitrogen and raffinose at a concentration of 0·6 gm. per 40 c.c. of medium

NaCl %	Lactose %	Wet weight of mycelium (gm.)	Titre
0·5	3	1·49	50
1	3	1·91	100
2	3	1·54	240

By means of the differential assay, we have found that the type of penicillin formed in most cases was penicillin –X–.

A full account of these investigations will be published elsewhere.

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Jan. 17.

[1] Cook, R. P., Tulloch, W. J., Brown, M. B., and Brodie, J., *Biochem. J.*, 39, 314 (1945).

[2] Cook, R. P., and Brown, M. B., *Proc. Roy. Soc. Edin.*, B, in the press (1947).

Australopithecinæ or Dartians

WHEN Prof. Raymond Dart, of the University of the Witwatersrand, Johannesburg, announced in *Nature*[1] the discovery of a juvenile *Australopithecus* and claimed for it a human kinship, I was one of those who took the point of view that when the adult form was discovered it would prove to be near akin to the living African anthropoids—the gorilla and chimpanzee[2]. Like Prof. Le Gros Clark[3], I am now convinced, on the evidence submitted by Dr. Robert Broom[4], that Prof. Dart was right and that I was wrong; the Australopithecinæ are in or near the line which culminated in the human form. My only complaint now is the length of the name which the extinct anthropoid of South Africa must for ever bear. Seeing that Prof. Dart not only discovered them but also rightly perceived their true nature, I have ventured, when writing of the Australopithecinæ, to give them the colloquial name of 'Dartians', thereby saving much expenditure of ink and of print. The Dartians are ground-living anthropoids, human in posture, gait and dentition, but still anthropoid in facial physiognomy and in size of brain. It is much easier to say there was a 'Dartian' phase in man's evolution than to speak of one which was 'australopithecine'.

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Downe, Kent.
Feb. 15.

[1] *Nature*, 115, 195 (1925).

[2] *Nature*, 115, 234 (1925).

[3] *Nature*, 159, 216 (1947).

[4] "The South African Fossil Ape-Men: The Australopithecinæ" (1946).

CAREERS IN ZOOLOGY

"CAREERS in Zoology—Possibilities and Training" was the subject of a discussion at the annual meeting of the Association of British Zoologists held in London on January 11. The Council had proposed this topic in an endeavour to provide those responsible for the teaching of zoology in schools, universities and kindred institutions with some guidance on openings likely to be available for young zoologists in the future and what, if any, special directions training should take.

Early in the discussion it became apparent that the field of employment in zoology is clearly divided into two parts: (i) teaching coupled with academic research, and (ii) applied work with research that is, to some extent at least, *ad hoc* and directed. All speakers who alluded to this division expressed their dissatisfaction with its existence, and stated that they believed that for the general health of zoology it is imperative to break down the division as soon as possible. Prof. J. Gray (Cambridge), opening the discussion, emphasized the desirability of encouraging first-class students to enter the applied field, where interesting but difficult problems await solution; increased facilities for fundamental research and a feeling of intellectual freedom are at least as important as high salaries. At present there is little relation between the supply and the demand for recruits; the numbers involved are often small, and no one could afford to undergo specialist training in such subjects as helminthology and protozoology unless assured of a reasonable career. Prof. Gray felt that many existing difficulties would be overcome if there were closer liaison between university teaching departments and institutions undertaking applied studies; he felt that much could be said for extending the principle whereby individuals should occupy simultaneously a university post and an official position under such organisations as the Medical or Agricultural Research Councils.

Dr. F. P. Coyne (Imperial Chemical Industries, Ltd.) suggested that what industry and commerce require of the entrant into the field of applied zoology is not that he be a ready-made specialist, but that he have a capacity for clear thinking. The idea that he need have an encyclopædic knowledge of a special field, or of the whole of zoology for that matter, is found among non-applied zoologists but not among those already in the applied field. Beyond a general training in zoology, the best additional qualification for applied work is probably a degree or diploma in agriculture. An acquaintance with statistical methods is also desirable, first so that the output of statistical departments can be appreciated, and secondly that experiments can be planned from the beginning in a form that will give results that statisticians can readily deal with. This does not, of course, mean that the zoologist should attempt to become a fully developed mathematician.

Prof. C. H. Waddington (Edinburgh) began his observations by pointing out that while Britain had, at one time, led the field in genetics, the subject has latterly fallen behind somewhat, and the main developments have been taking place elsewhere. Genetics cannot be purely a study of breeding experiments, but successful research is dependent on parallel advances of knowledge in the physiology of plants and animals, and in the analysis of exactly what factors contribute toward the qualities of plant or animal that it is desirable to improve. He illustrated this by pointing out some of the many factors that contribute toward a satisfactory milk-yield in dairy cows. Another field in which advances are due to be made is that of genetics in relation to general evolutionary processes. Prof. Waddington suggested that genetics should be more integrated into the general subject of analytical biology, and the past tendency towards the separation of genetics from zoology should, if possible, be reversed. Future laboratories of genetics will require zoologists as well as specifically trained geneticists.

Speaking of fisheries research and work on marine biology generally, Mr. Michael Graham (Fisheries Laboratory, Lowestoft) pointed out that while proposed developments may lead to an average intake of some two or three individuals every year, this could not be expected to be a regular intake owing to inevitable inequalities in age-groups employed. He therefore suggested that while an individual student might well train for fisheries or other marine research, if aptitude had been shown, he would be well advised to have a good alternative subject, with which to seek employment should openings in fisheries and related work prove to be few and far between. Mr. Graham pointed out that it is now possible to gain some information about the financial side of careers in zoology by reference to the White Paper on the Scientific Civil Service, since the conditions laid down therein apply to work undertaken or supported by Government institutions, and would certainly be used as a guide by the majority of research stations.

An interesting account of developments in the relatively small field of research on the anti-fouling of ships was given by Prof. J. E. Harris (Bristol). He pointed out that while this work will be almost certain to continue, it cannot be expected to absorb a large number of zoologists. Prof. Harris emphasized that this applied work brings the research worker into contact with fundamental problems of marine biology; and that those who control financial aspects are becoming convinced that the division between the applied field and the non-applied is, perhaps, much less apparent in this field than elsewhere.

Dr. E. L. Taylor (Veterinary Laboratories, Weybridge), discussing veterinary science generally and helminthology in particular, pointed out that work in these fields tends perhaps to overlap into other fields to a greater extent than any other type of work in which zoologists normally find employment. However, it would not be desirable to add pharmacology, for example, to the zoologist's equipment; but perhaps the general subject of parasitism in all its manifestations, and including immunity, might receive more attention in the general training of zoologists. Dr. Taylor stressed the fact that the fundamental approach to the problems of parasitic diseases is ecological, since all these diseases are, on final analysis, the result of man-made derangements of environment. Losses due to parasitic disease are enormous, and it is to be hoped that, in future, zoologists, even if in limited numbers, may find employment in this field.

The field of employment before the young entomologist was analysed by Dr. V. B. Wigglesworth (Cambridge). It consists—with exceptions, of course—of a limited number of openings in teaching, which is in fact part of pure zoology; a limited number in systematic entomology or museum work; and a much larger number in applied work. An applied entomologist is primarily an investigator, and he is not fully trained until he is acquainted with the industry which he serves. University training should therefore aim at a synthesis of insect morphology, physiology and taxonomy, and afterwards a year or two of research. In addition, the applied entomologist will require at some stage a training or a period of apprenticeship in the industry which he is to serve. Dr. Wigglesworth concluded by enumerating some of the very diverse organisations wherein entomologists can seek employment if prepared to carry out applied work.

In the general discussion among members which followed the introductory papers, a number of points were made. It was suggested that biology, and therefore zoology, is now such a complex subject, with roots deep down in chemistry, physics and mathematics, that certain preliminary training in these subjects should be insisted upon before work in zoology itself is commenced at any other than a most elementary level. Such training is required for medicine; why should zoology exempt its trainees from being of a certain educational standard in such very relevant subjects? The great need for systematic zoologists was mentioned, but the opinion was expressed that systematists gradually develop in the course of general zoological training, and few, if any, could be specifically trained for taxonomic work. In any event, systematics is a very specialized field, and a relatively small one compared with the rest of the general field of zoology.

One speaker suggested that the rising cost of living, along with the relatively poorer career prospects in biology, is leading to an ever larger number of potential zoologists taking up medicine rather than zoology; but this point of view was immediately controverted by another speaker.

The fact that zoologists appear to have succeeded in a great number of non-zoological war jobs was cited as showing that zoology as a discipline has very considerable educative value, as distinct from being a subject of training in a specific technical field, and that it is desirable that this should be stressed. To speak of 'training' in zoology implies in itself that the trainee is to become a professional zoologist. No one would talk of a 'training' in classics, but an 'education' in classics was held to fit a man for almost any job where administration is involved. Is there anything that makes the man 'educated' in the classics or such similar subjects automatically a better potential worker than the man 'trained' in zoology?

JOHN SMART

MODERN METHODS OF FIBRE INVESTIGATION

STUDIES on the properties of single fibres have been particularly successful in increasing our knowledge of the structure of natural and synthetic high polymers and of the basic principles underlying many industrial processes. Special techniques have been developed to overcome the experimental difficulties involved in making measurements on single fibres, and many of these methods were discussed at a Conference on Single Fibre Testing held by the Textile Institute in the University of Leeds on January 29. The February issue of the *Journal of the Textile Institute*, in which the papers read at the Conference are published, forms a valuable addition to scientific literature, and will be a useful practical reference volume for all who are interested in this field of investigation.

Determinations of breaking load, extension at break, and other elastic properties which have attracted many workers were discussed by R. Meredith, and an instrument designed by J. Sikorski, C. S. Whewell, and H. J. Woods was described in detail on account of its having proved satisfactory for making such measurements over a period of ten years. Interest in studies on bending has recently been intensified, and measurements of bending modulus may be made simply by the use of apparatus described by P. Carlene and by L. G. Wilson. R. H. K. Thomson and D. Traill gave an account of an apparatus designed to assess the resistance of fibres to repetitive bending—a property which is equally important, although some doubt was expressed as to the correlation between results obtained by this method and those obtained on material in bulk. Deformation of fibres by shearing stresses was considered by A. Finlayson, and papers by R. Meridith and by W. E. Morton and F. Permanyer supply details of satisfactory methods for measuring torsional rigidity and torsional relaxation, which are particularly significant in relation to the spinning of textile fibres. Determination of axial swelling by direct microscopic observation is slow and difficult, especially with fibres of varying and irregular cross-sections, but new methods of measurement devised by J. M. Preston and S. Das Gupta and by F. L. Warburton are much simpler.

Other fibre properties, less frequently studied, were the subjects of a contribution by J. M. Preston on the refractive index of textile fibres, and an interesting account of preliminary experiments by G. E. Collins on the surface tension method for measuring the perimeter of a fibre and the contact angle.

Weighing the single fibre is a necessary operation in most investigations, and has in the past been done by using torsion balances. These instruments are delicate and often lack stability, but the cantilever microbalance of E. Lord is more robust and stable, and is very suitable for routine work.

Sampling is one of the most important aspects of single fibre testing, and statistical analysis of the results is in most cases necessary. These topics were discussed by R. C. Palmer and H. E. Daniels, who illustrated their contribution by reference to the measurement of fibre length. The value of modern single fibre testing is possibly best illustrated by the results which have been obtained on animal fibres, for although opinions may differ on the detailed interpretation of certain observations, studies on the properties of natural and chemically modified animal fibres under various conditions have been particularly successful. Some of this work was described by J. B. Speakman, who gave a lucid account of the uses of load/extension curves, set, and supercontraction in the routine control of wool textile processes as well as in research on the chemistry of animal fibres. The new techniques developed by R. D. Preston and by F. Happey and A. W. Porter for obtaining X-radiograms of single fibres should also prove valuable in investigations on the structure of fibres.

C. S. WHEWELL

FORTHCOMING EVENTS

Saturday, March 22

BRITISH INSTITUTE OF RADIOLOGY (at the French Institute, Queensberry Place, London, S.W.7), at 10.15 a.m.—Prof. D. W. Smithers: "The Radiotherapist and the Cancer Patient" (Presidential Address); at 2 p.m. (at the Royal Cancer Hospital (Free), Fulham Road, London, S.W.3).—Demonstrations.

Monday, March 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. J. A. V. Butler: "Enzymes—their Isolation, Structure, Mode of Action and Place in Nature" (Cantor Lectures, 3).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. F. E. Brown: "Engineering Economy in the Rubber Factory".

ROYAL STATISTICAL SOCIETY, SHEFFIELD BRANCH of the INDUSTRIAL APPLICATIONS SECTION (in Room B1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Mr. K. A. Brownlee: "The Value of the Factorial Experiment in Chemical Investigations and its Development".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (joint meeting with the ASSOCIATION OF LONDON STUDENTS OF THE INSTITUTION OF CIVIL ENGINEERS and the LONDON GRADUATES' SECTION of the INSTITUTION OF MECHANICAL ENGINEERS, at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Short papers on "Hydro-Electric Power Schemes".

INSTITUTE OF BRITISH FOUNDRYMEN, SHEFFIELD BRANCH (at the Royal Victoria Station Hotel, Sheffield), at 7.30 p.m.—Mr. G. W. Nicholls: "Machine Tool Castings".

Tuesday, March 25

FEDERATION OF BRITISH INDUSTRIES (at the Queen's Hotel, Birmingham).—Conference on "Industry and Research". At 10 a.m.—"Research and Economic Recovery"; at 2 p.m.—"Industrial Research in the Midlands".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Sir Theodore Tasker: "Prehistory and Anthropology in the Hyderabad Deccan".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. H. Wrighton: "Reflections on War-time Steel Inspection".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. R. Meakin: "Electronics in Non-destructive Testing".

Wednesday, March 26

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, 16 Princes Gate, London, S.W.7), at 3.15 p.m.—Mr. M. E. Clarkson, Dr. O. L. Davies and Dr. T. Vickerstaff: "A Statistical Investigation of some Aspects of Colour Harmony".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Dr. A. J. Turner: "Flax Utilisation".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. Kenneth Mellanby: "Human Water Requirements" (all members of the Food Group are invited).

INSTITUTION OF NAVAL ARCHITECTS (at 10 Upper Belgrave Street, London, S.W.1).—Annual General Meeting.

Thursday, March 27

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Air Vice-Marshal E. B. Addison: "The War in the Ether".

SHEFFIELD METALLURGICAL ASSOCIATION, REFRACTORIES GROUP (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. E. Pluck: "Open Hearth Refractories and Insulation".

TEXTILE INSTITUTE, BELFAST SECTION (at the College of Technology, Belfast), at 7.30 p.m.—Dr. R. G. Fargher: "Trends in the Continuous Processing of Textiles".

Friday, March 28

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5 p.m.—Annual General Meeting. Mr. J. A. Sumner: "The Norwich Heat Pump"; Mr. T. F. Thomas: "The Air Cycle Heat Pump".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "Eclipsing Variable Stars".

Tuesday, March 25—Friday, March 28

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2).—Convention on "Radiocommunication with particular reference to War-time Activities and their possible Influence on Peace-time Development".

Tuesday, March 25

At 5.30 p.m.—Sir Stafford Cripps, P.C.: Opening Ceremony. Colonel Sir Stanley Angwin, K.B.E.: "Telecommunications in War".

Wednesday, March 26

At 9.45 a.m.—"Long Distance Point-to-Point Communication"; at 11.30 a.m.—"Naval Communication"; at 2.30 p.m.—"Military and Aeronautical Communication"; at 6 p.m.—"Pulse Communication".

Thursday, March 27

At 9.45 a.m.—"Short-Distance Communication" (1); at 11.30 a.m.—"Short-Distance Communication" (2); at 2.30 p.m.—"Direction-Finding"; at 6 p.m.—"War-time Broadcasting".

Friday, March 28

At 9.45 a.m.—"Propagation"; at 2.30 p.m.—"Radio Components"; at 6 p.m.—Sir Clifford Paterson, F.R.S.: "Review of the Convention and Future Trends".

Wednesday, March 26—Friday, March 28

INSTITUTION OF NAVAL ARCHITECTS (at the Royal United Services Institution, Whitehall, London, S.W.1).—Eighty-eighth Annual Meetings.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR ATTENDANT (Grade A Technician, male or female) to take charge of the small-animal colony—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (March 31).

LECTURER IN TEXTILE CHEMISTRY—The Registrar, College of Technology, Manchester 1 (March 31).

LECTURER IN CHEMISTRY—The Secretary, The University, Aberdeen (April 4).

SOIL CHEMIST, and a MYCOLOGIST, in the Kenya Forest Department—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (April 5).

CHAIR OF ZOOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (April 14).

CHAIR OF PHONETICS tenable at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 15).

AGRICULTURAL CHEMIST in the Nyasaland Department of Agriculture—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1 (April 15).

DEWAR RESEARCH FELLOWSHIP, tenable in the Davy Faraday Research Laboratory—The General Secretary, Royal Institution, 21 Albemarle Street, London, W.1 (April 15).

LECTURER IN THE DEPARTMENT OF PHYSICS—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 24).

PROFESSORS (2) OF MATHEMATICS (one with special qualifications in Hydro- and Aerodynamics, the other in Statistics)—Prof. S. Beatty, Department of Mathematics, University of Toronto, Toronto, Canada (May 1).

FELLOWSHIP associated with the memory of the late Mr. E. B. Stringer—The Bursar's Clerk, King's College, Cambridge (May 1).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 18: The Influence of Mechanical Treatment of Milk and Cream on the Size Distribution of the Fat Globules. By J. Lyons. Pp. 249–272. 2*s*. Vol. 3, No. 19: The Feeding Value of Seaweeds. By B. J. Senior, P. Collins and M. Kelly. Pp. 273–292. 2*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946.) [2611

National Central Library. 30th Annual Report of the Executive Committee for the Year ending February 28th, 1946. Pp. 26. (London: National Central Library, 1946.) [2811

Chemical Council. Tenth Report, 1945. Pp. 8. (London: Chemical Council, 1946.) [2811

Forestry Commission. Leaflet No. 2: *Adelges cooleyi*, an Insect Pest of Douglas Fir and Sitka Spruce. Revised edition. Pp. 4. Leaflet No. 5: Conifer Heart-Rot. Revised edition. Pp. 8. Leaflet No. 14: The Phomopsis Disease of Conifers. Revised edition. Pp. 4. Leaflet No. 17: Chafer Beetles. Revised edition. Pp. 12. Leaflet No. 18: Two Leaf-Cast Diseases of Douglas Fir. Revised edition. Pp. 8. (London: Forestry Commission, 1946.) Free. [2811

Instrument Practice. Edited by Dr. H. B. Cronshaw. Published monthly. Vol. 1, No. 1, November. Pp. 42. (London: United Trade Press, Ltd., 1946.) Subscription, 30*s*. per year. [312

The Rationalist Annual for the Year 1947. Edited by Frederick Watts. Pp. 110. (London: C. A. Watts and Co., Ltd., 1946.) 2*s*. net. [312

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 196: Transmission of Potato Virus Diseases, 5, Aphid Populations, Resistance and Tolerance of Potato Varieties to Leaf Roll. By J. G. Auld, D. O. Norris and G. A. H. Nelson. Pp. 32. (Melbourne: Government Printer, 1946.) [2511

Smithsonian Institution: United States National Museum. Bulletin 192: The Operculate Land Mollusks of the Family Annulariidæ of the Island of Hispaniola and the Bahama Archipelago. By Paul Bartsch. Pp. iv + 262. (Washington, D.C.: Government Printing Office, 1946.) 75 cents. [2611

Imperial College of Tropical Agriculture. Interim Report on Cacao Research, 1944–45. Pp. 4. (Trinidad: Imperial College of Tropical Agriculture, 1946.) 1*s*. [2611

Bergens Museum. Årsberetning, 1938–39. Pp. 114. Årsberetning, 1939–40. Pp. 101. Årsberetning, 1940–41. Pp. 97. Årsberetning, 1941–42. Pp. 87. Årsberetning, 1942–43. Pp. 94. (Bergen: A/s John Griegs Boktrykkeri, 1939–1943.) [2811

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DEVELOPMENT COUNCILS IN INDUSTRY

THE anticipated Bill to give effect to the recommendations of the reports of the 'working parties' set up by the Board of Trade, and particularly to provide for the use of a compulsory levy to support scientific research, has now been published and received its second reading in the House of Commons on February 13. The debate on this Industrial Organisation Bill, however, scarcely touched on the issues which are disturbing to those most closely concerned with research, and it is to be hoped that its clauses will receive much more searching and constructive criticism when the Bill reaches the House of Lords. In spite of the fact that all the reports so far received from the 'working parties' have favoured a compulsory levy, it is by no means certain, as Mr. I. J. Pitman and Mr. W. Shepherd pointed out in the House of Commons, that duress will prove more effective than persuasion for the purpose in mind.

The Bill enables any of the ministers specified in the Bill, including the President of the Board of Trade, and the Ministers of Agriculture and Fisheries, Supply, Food, and Fuel and Power, after consultation with organisations of workers and employers in an industry, to establish a development council for that industry. The general objects of such councils are to increase the efficiency and productivity of the industry concerned, and to enable it to render better and more economical service to the community. For this purpose a development council may be authorized to promote or undertake scientific research or research into industrial psychology, the incidence, prevention and cure of industrial disease, the marketing of products, or the consumption or use of goods and services supplied by the industry. A council may also be empowered to promote inquiry into materials and equipment, methods of production, management and the utilization of labour, the improvement of design, the production and marketing of standard products, the training of personnel and improvement of working conditions as well as the collection and formulation of statistics. A council may also be authorized to collect a levy to finance its activities, the maximum rate of such levy being laid down in the order establishing the council. These orders must be first approved in draft by both Houses of Parliament, and the main features of the constitution of the councils are determined in the Bill, which provides for the appointment of their members by the minister concerned, and that they shall consist of persons capable of representing the interests of employers and workers in the industry, with independent persons, one of whom will be appointed chairman by the minister. There are rigid restrictions on the disclosure by members of a council, or its officials, of information relating to individual businesses, and a further clause empowers the minister concerned to collect a levy from an industry for which no development council exists, if he considers it necessary that finance should be made available for the promotion of scientific research, the development of exports or the improvement of design in that industry. The Board of Trade is also empowered to make grants to the Council of Industrial Design or to any other non-profit-making body the objects of which include the improvement of design in industry.

In moving the second reading, the President of the Board of Trade stressed the importance of flexibility in applying any pattern of organisation, and did not suggest that it would be desirable to deal with every industry under the Bill. But while he was careful to avoid any suggestion that the work of the joint industrial councils should be disturbed, and insisted that production and development matters should be kept separate from negotiations as to wages and conditions of work, the first criticism that will be made, apart from the question of the validity of compulsion, by the scientific worker at least, is that the activities of the development councils may overlap seriously within their own ranks and with one another. That criticism was indeed advanced in the debate by Mr. Mikardo and by Mr. Mallalieu. Admittedly, many of the functions scheduled in the Bill are appropriate for co-operative effort and even demand it. The question is rather whether that effort should not be made on an even wider basis than the limits of a single industry.

That very clearly may be true of such matters as industrial psychology, where it might be thought that to develop the work of the National Institute of Industrial Psychology is the appropriate means to adopt. Again, as regards industrial health and disease, it might equally be argued that further support should be first extended to the Industrial Health Research Board, while as regards management and training there is much to be said for encouraging the work of the Institute of Industrial Administration or the new British Institute of Management, rather than fostering new and unrelated sectional activities in the same field. Mr. Mallalieu and Wing-Commander Shackleton in particular were concerned with the danger of dissipating effort here, and the former also observed that the improvement of working conditions, even the 'spring-cleaning programme' advocated by the Chief Inspector of Factories in his last report, is essentially a matter for Government assistance with priorities in materials and labour. On the question of research, the Bill encourages no more confidence than the reports of the 'working parties' themselves, several of which have shown a most inadequate appreciation of the nature of research and the conditions for its effective prosecution.

That point indeed did not entirely escape notice in the debate. Mr. Rhodes asked specifically how the Bill was related to the grants from the Department of Scientific and Industrial Research and also to the grants from the Council of Industrial Design. Mr. Belcher, replying for the Government, stated that development councils would work through, and would not supersede, research associations and design centres. Contributions to these bodies from a development council's research levies would count as industrial contributions and would be eligible for the appropriate Government grants from the Department of Scientific and Industrial Research in regard to research and from the Board of Trade in regard to design. Sir Stafford Cripps had also earlier disclaimed any idea of compulsion in regard to research. Here a development council could help and advise; but its compulsory powers, when granted, were to be limited to the collection of statistics, the registration of persons in industry and the collection of a levy.

Sir Stafford Cripps was more concerned with the danger that the councils might be liable to try to adopt and encourage restrictive practices, which would be inimical to the consumer and to the general national welfare. That danger may be inherent in bodies the members of which are representative of an industry, rather than chosen with a view to the fitness of the individual member for the job to be done. Although Sir Stafford indicated the Government's intention to take active steps to stop the encouragement of restrictive practices by a development council, that is not an easy task in practice, nor is there any certainty that other Governments would be equally concerned to try. Moreover, there is an equally serious danger to which Mr. Pitman referred in the able speech already noted, namely, that of industry tending to shuffle the responsibility for dealing with its problems on to the development councils.

Such a tendency can be seen in the trend of some of the reports from the 'working parties', and it is well illustrated by the coal industry at the moment. Something of the acuteness of the fuel crisis might well have been mitigated had, for example, more note been taken of such reports as that on "Coal Utilisation Research and the National Economy" which the Parliamentary and Scientific Committee forwarded to the Lord President of the Council in May 1943. It was left to Lord Marley to direct attention to this factor in the debate on the coal situation in the House of Lords on February 13. Referring to the inefficient utilization of coal and the waste of coal resources by industry, Lord Marley cited not only the work of the British Coal Utilisation Research Association, the British Colliery Owners' Research Association, the Gas Research Board, the Fuel Research Station and other stations of the Department of Scientific and Industrial Research, but also an important report in 1943 from the Select Committee on National Expenditure; from all these sources many recommendations had been made for the saving of coal in the production of power and heating of buildings and plant, but industry had neglected them. This picture of twenty years of neglect of available knowledge and wasted national assets should give pause to any elaborate proposals for development from outside. The results of research will only be utilized when management, particularly in the smaller firms, becomes research-minded, and that change of outlook will often of itself induce the undertaking of research by such firms.

The prosecution and utilization of research by industry depend fundamentally, as we have so often urged, upon having men with the scientific outlook and training on the boards of management and directors, and there is no short cut which can wisely be taken to avoid the slow task of education and persuasion. It is not easy at first sight to see what more the development councils could contribute here that existing organisations could not already supply. It is true that they may do good in different directions; on the other hand, they may do little to justify their cost and may still discourage private initiative. Any element of compulsion in relation to research is to be distrusted on *a priori* grounds, and only used as a last resort. Where persuasion by other means is possible it should be tried, and such opportunities of indirect stimulus to research as we once had under the Import Duties Advisory Committee should not again be missed.

Everything, in fact, will depend on the membership and staff of any development councils, and the extent to which the idea, not of sectional represention of one side of an industry or another, or of one set of private interests rather than another, but of the welfare of the industry as a whole and of the service of the community, sets the standard for their policy and administration. It is a question of men rather than of organisation, and in setting up such councils the Government will do well to press forward by every means in its power those developments such as the British Institute of Management which promise to increase the supply of trained administrators and managers, qualified to appreciate and assess advances in science and to apply them to the purposes of the industry in which they are engaged. None the less, it is important that the organisation which the Bill proposes to establish should be subjected to a most careful scrutiny, such as Mr. Pitman also suggested, to determine how far it is in keeping with the cardinal principles of organisation on which any such scheme must be based. Mr. Pitman indeed, from his experience as director of the Organisation and Methods Division of the Treasury, believes that departure from the voluntary principle is a fatal defect in a body in which the co-operation of employers, management and workers is involved; and the danger of an overlap of functions and responsibility which was stressed from both sides of the House in the debate indicates the need for a close examination of such relations, for clearer definition of functions as between the industries and various national functional bodies. What is certain is that failure to serve sound administrative principles in the organisation of the councils and in defining their functions will be a fatal obstacle in attracting to their service the first-class men who are indispensable to the success of the whole scheme. Whether or not the development councils can do anything that the joint industrial councils could not equally well foster, it appears essential that their compulsory powers should be used both with restraint and discretion. It is equally important that care should be taken to see that they involve no further dissipation or waste of our precious resources of trained man-power, either in the scientific or in the technical field.

PRE-NATAL PHYSIOLOGY

Researches on Pre-Natal Life

By Sir Joseph Barcroft. Vol. 1. Pp. xiii + 292. (Oxford: Blackwell Scientific Publications, Ltd., 1946.) 37*s.* 6*d.* net.

THIS book is the first of its kind; it may be described as a work on physiological ontogeny; that is to say, it deals with the development of function in the progress of fœtal life. Moreover, it keeps in view throughout, not only the intra-uterine conditions under which the fœtus lives and grows, but the fact that the fœtus will eventually pass out into the world and in such a state that it can respond successfully to its new environment. The book deals mainly with investigations by the author himself and his colleagues and pupils in the Schools of Physiology and Agriculture in Cambridge. It does not claim to be a text-book on the subject, and so does not include such work as has been done in other centres like that on the initiation of the heart beat carried out at the Johns Hopkins University. Nevertheless, it covers very considerable ground, and the relevant papers by other investigators are duly quoted. The researches were mostly upon the fœtal sheep, and it is impossible to refrain from an expression of admiration for the ingenuity of the investigator and for the results which he obtained, especially when one bears in mind the great difficulty that must have been experienced in dissecting fœtal lambs so as to preserve any considerable degree of normality. Wherever possible the author has correlated his observations and those of others so as to give a connected story of the physiological events studied. But he very wisely does not always attempt this, and at the beginning of the chapter on the oxygen capacity, he says frankly that he decided to record a series of unconnected observations rather than to arrange them under some hypothetical scheme. For here, as in other parts of the book, the facts are not only interesting but also beautiful in themselves, and need no scientific hypothesis to make them more so.

The first two chapters are on the disposition of vessels in the placenta and the crossing of the placental barrier, and the author begins with a comparison between placental and fœtal growth in the sheep; and it is shown that whereas the fœtus puts on weight every week, the cotyledons of the uterus, after reaching a maximum at about ninety-five days, proceed to decline. It is not clear how much the maternal growth during pregnancy depends upon the fœtus, and it is known that some uterine development (at least in certain species) occurs after ovulation in the absence of a fœtus. With regard to the matter of permeability the author finds that, contrary to the views of Flexner, the greater the number of layers in the fœtal barrier, the more perfect is the fœtus at birth, and he instances the horse with a six-layer placenta, quoting an experience of Hammond, who found that a newly born foal was so perfect at birth that it ran away promptly and could not at first be caught. The author emphasizes that though the several types of placenta differ much, they all serve their purpose in their own way, but that the great surface which among other varying devices promotes the passage of material across the fœtal membrane is present in all forms of placenta. The passage of oxygen from the mother to the fœtus is simply one of diffusion, as Huggett and others have concluded. It is shown, further, that fatty food substances vary with the maternal ones, but that sugar in sheep and goats is present in greater quantity in the fœtal blood than in the maternal. The author quotes experiments by Passmore and Schlossmann showing that by injecting glucose into the mother the glucose content of the fœtal blood can be raised. The deduction seems clear, both in the case of fats and sugars, that by altering the diet of the mother the food contents of the fœtus may also be modified, and this is a conclusion of great practical importance for breeders of farm animals.

The next chapters, on growth, contain interesting comparative studies, and Hammond's observations on the pig are quoted, showing that embryos perish *in utero* and at varying stages of development, and that this is not usually due to overcrowding, for it may occur in any part of the uterus. The work of Wallace and that of Carlyle is referred to, showing that the various organs of the fœtus undergo their maximal development at different times; even within the same organ (for example, the gut) the different parts have their critical periods of growth, and bones develop at different rates. At birth, blood is one of the four bodily constituents of major weight, the other three being skin, skeleton and muscle. The last three or four weeks of pregnancy are the great blood-forming period. The question arises as to whether, at specific times during gestation, special foods should not be fed to the mother. This question, together with the more general one of the relations between maternal nutrition and fœtal development, is dealt with again in Chapter 5, which concludes by remarking on the special importance of this subject in the present age when the possibility of semi-starvation is confronting a large part of the world. The author quotes Hammond, who has shown in his experiments on pigs and rabbits that the larger and better nourished the mother the larger are the young; and Wallace has proved quite definitely for the sheep that by altering the diet of the mother one can influence the growth of the offspring. Nevertheless, the fœtuses may have their own intrinsic growth mechanisms which vary from individual to individual.

The seventh chapter is upon the transfer of blood from the placenta to the fœtus at birth, and numerous experiments involving the tying or clamping of the umbilical cord are described. It is shown that the average amount of blood transferred was 120 c.c. or 39 c.c. per kilo, which is not very different from that found in man. The presumption is that the blood is expelled as a result of the umbilical and placental vessels contracting.

The water content of the fœtal tissues is next dealt with, and then the basal consumption of oxygen of the tissues of the sheep fœtus at different ages. The cardiac output is the subject of the tenth chapter, and it is shown that this is much greater towards the end of pregnancy.

The following chapters are on blood pressure and the development of vascular reflexes, and in reading the accounts of the several experiments one is impressed by the difficulties involved but successfully overcome in applying a difficult technique. That there should be great variability in the different species was to be expected in view of the varying degrees of development at birth. Among other interesting points, it is shown that the venous pressures do not rise like the arterial ones, but remain fairly constant after the fiftieth day. Slowing of the heart beat by vagus stimulation could occur on the seventy-seventh day in the sheep. The pulse-rate was found to become progressively slower after the ninety-third day. In the chapter on the oxygen dissociation curve the subject is complicated by the fact that there are two sorts of hæmoglobin, the myohæmoglobin of muscle and that found in normal blood. In the earlier stages of fœtal life hæmoglobin is made very largely in the liver, and this may give rise to myohæmoglobin.

In the chapter on acid-base equilibrium and carbon dioxide dissociation curves the work of Huggett and Keys is dealt with, and it is shown that the carbon dioxide pressure is almost certainly higher in the fœtal than in the maternal blood, and that the hydrogen ion concentration of the fœtal blood is less than that of the maternal. Further, Keys found that the dissociation curve of a pregnant goat was below that of the control, but the fœtal dissociation curve as compared with that of the mother might be either above or below. In the chapter on the oxygen in the umbilical vessels the fact emerges that while all other factors fluctuate widely the oxygen content in the umbilical vein is almost constant. The author comments on the similarity between the oxygen content of the blood in the umbilical artery and that in the thoracic vena cava. Later, he gives the evidence that there is a sphincter at the umbilical end of the ductus venosus which contracts after delivery. Another point of interest is that the foramen ovale is not 'just a hole', for as shown by Barron and by Franklin, it constricts with each heart beat. In the nineteenth chapter the author shows that the view taken by Wolff a hundred and fifty years ago, that the streams of blood which reach the right side of the fœtal heart do not completely mix, is correct. Kennedy and Clark are quoted as demonstrating that oxygen, and not just any gas, causes the closure of the ductus arteriosus, and that this does not result from nervous stimulation.

Chapter 21 is on the respiratory process, and it is shown that this is very efficient for the fœtus, at least up to the 120th day, since the vascular bed in the placenta is large. Later, the conditions deteriorate as the end of pregnancy draws near, and "the fœtus is approaching a crisis . . . the alternative between death and escape". The last chapter deals with the onset of respiratory movement, and the author describes how at halfway through gestation in the sheep the fœtus, after having been temporarily inert, is already capable of making normal respiratory movements as a result of occluding the umbilical cord, though it cannot breathe if only because the lung is solid.

The high degree of perfection to which the fœtus has attained in co-ordinating its functional activities in the progress of growth and development must be a matter of constant wonder to the investigator, and one is reminded of the words of Samuel Butler: "Birth is the end of the time when we really knew our business, and the beginning of the days when we know not what we would do, or do".

The volume is dedicated to D. H. Barron, with whom the author collaborated in so many of his researches. In a brief notice such as this only a very few of the observations recorded have been quoted, and it has been difficult to make a selection. The book needs to be read in order that its scope may be realized and its originality appreciated. It is to be followed by a second volume dealing with the nervous system and the principles of metabolism.

F. H. A. MARSHALL

AGRICULTURAL BOTANY

Principles of Agricultural Botany

By Dr. Alexander Nelson. Pp. xvii+556+128 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1946.) 35*s*. net.

THE publication of a new text-book of agricultural botany is something of an event, since only one has been available hitherto. This paucity is due to two main reasons. First, agricultural botany scarcely exists as a unitary subject in the United States and most other countries, its content being subdivided and variously allocated. Secondly, the need for a text-book has previously been met by Percival's "Agricultural Botany", which has run into eight editions and been translated into various languages. This book, first published in 1900, was a remarkable pioneer work which appeared in its last edition only ten years ago. But, during the past three decades, the approach to the subject of agricultural botany has changed, the content of the subject has expanded and acquired new orientations, and the outlook of agricultural botanists has developed in relation to advances in 'pure' science and in agricultural science and practice. Percival's book, valuable as it is and in many ways still indispensable, has changed but little in its successive editions, and there is need of a treatise reflecting the modern state of agricultural botany that will serve teachers and students to-day as well as Percival's volume served those of earlier years. Nelson's "Principles of Agricultural Botany" must be viewed against this background.

One is, perhaps, a little disturbed by the title of the book. Agricultural botany is not an autonomous science; it is merely the diffused area of scientific knowledge which forms the meeting-ground of botany with various other sciences and empirical practices. Its content and boundaries are determined by the sole criterion that the plants with which it deals are, in their crop husbandry relationships, useful or harmful to man. The principles involved in its study are principles of botany and certain cognate sciences, not of agricultural botany.

The book is organised in four sections: morphology and anatomy; physiology; negative factors in food production; and heredity, evolution and classification. Section 1 opens with a chapter on "Food in General" which might better have been placed in section 2. The author then discusses the elements of plant form and structure, which leads to an exposition of the modifications of 'standard type' seen in agricultural plants. A discussion of the elements of plant reproduction similarly leads to a detailed consideration of the special aspects of the inflorescence, flower, fruit and seed of these plants. The student thus proceeds from certain general principles of botany to special examples chosen from agricultural botany, and, by the end of section 1, has acquired a considerable amount of information concerning crop plants. In section 2, principles and technical data are more closely interwoven. Much modern physiological research of a fundamental nature has been carried out on economic plants, and the author can thus illustrate his exposition of principles by direct reference to crop plants and agricultural conditions. There is, however, the same general trend from principles to special information, the introductory chapter, which some agricultural students may not survive, dealing with abstruse "Fundamental Concepts", while the section closes with a purely technical chapter on "Pasture". Section 3, in both contents and text, is headed "Weeds; Insect Pests; Disease", but the four chapters give a brief account only of weed biology and control and of diseases caused by environmental factors, viruses, fungi and bacteria. The student is again introduced to certain relevant principles; but he acquires little of the technical knowledge of these subjects expected of a well-trained agricultural botanist. Section 4, on "Heredity, Evolution and Classification", contains only two chapters, which give a still briefer and less adequate account of these subjects.

Thus, the general balance of the book cannot be regarded as satisfactory and, in view of the fundamental importance in agriculture of the subject-matter of sections 3 and 4, the author's admission in his preface that "it may appear that some subjects have received rather cavalier treatment" would seem more correct than his claim that "Nevertheless, matters of botanical interest significant in agriculture have received adequate treatment". Further, the author's discussion of his subject-matter is very unequal, section 1 being written at about agricultural college level, section 2 at about university level, and the last two sections at about farm institute level. Certainly, from my experience of examining in various universities, the book does not substantiate the author's claim that it assembles "all the information likely to be required by you when preparing for a formal examination in Botany, leading to a degree or diploma in Agriculture". Moreover, although, on the whole, the text is simple and straightforward, there are many awkward sentences, some statements that are ambiguous or dubious, others that are positive misstatements and, occasionally, some serious errors. Further, in many respects, the author's treatment of his material is not up to date.

One of the most disturbing features of the book is the author's adoption throughout of vernacular names of plants, scientific names being virtually absent. This, in spite of the fact that he recognizes that "Unfortunately, these 'common' names differ in different districts or areas. . . . A name universally used for the same species all the world over is required. Science is international, and scientists must be able to write and speak about a plant so that scientists everywhere can understand just what particular plant is meant." In these days, when even school-children and growers are becoming familiar with the scientific names of plants and appreciative of the reasons for their usage, Dr. Nelson's practice seems incomprehensible. Each chapter closes with a short list of books for further reading and, apart from misspelling of authors' names and errors in citation, these lists are often unsatisfactory.

The format of the book is almost that of an 'edition de luxe', and it contains 182 text-figures, 128 half-tone plates and 17 plates in colour. Many of these illustrations are original and most of them are of high quality, although there are some bad lapses, and one can understand the author's grateful acknowledgment to his publishers "whose enthusiasm has made the book possible". On the other hand, the sumptuous format, practically all the coloured illustrations, very many of the half-tone plates and many of the text-figures are entirely unnecessary, and a more restrained enthusiasm might have produced an equally useful book at a much lower price. Most agricultural students will look several times before paying thirty-five shillings for a text-book that covers inadequately only a portion of their course in agricultural botany. The author had a great opportunity, and one can only regret that he has not made the best use of it.

W. B. Brierley

PHILIPPINE BIRDS

Birds of the Philippines

By Jean Delacour and Ernst Mayr. (Pacific World Series.) Pp. xv + 309. (New York: The Macmillan Company, 1946.) 18*s.* net.

In a foreword to this volume, Prof. Fairfield Osborn explains that it is one of a series brought out under the auspices of the American Committee for International Protection of Wild Life. The object of this series, which deals with all branches of animal life and plants, is to make known to the public "the wonder and beauty of natural things" and create a desire to protect and conserve the fauna and flora of the islands of the Pacific and neighbouring lands. Much of the pioneer work on the avifauna of the Philippines was done by two famous English collectors, A. H. Everitt and John Whitehead, and the Marquis of Tweeddale made the birds of these islands his special study. Macgregor's "Manual" was for long the standard authority, and some eleven years ago Hachisuka commenced an ambitious work, of which not more than five parts appeared—but like all that writer's work it is a mere compilation.

This volume now brings our knowledge up to date in a very condensed form and is a valuable addition to the ornithological literature of the area. It is unfortunate, however, that more space has not been devoted to the habits and biology of the different species, which are of more interest to the general reader than the details of subspecies. Then, too, in the chapter on the bird geography of the islands the entire absence of English names is apt to be rather disconcerting to the general reader. To the student of geographical variation the book supplies much useful information, and nowhere can this subject be better studied than in the Philippine Islands. Take, for example, the striking crimson-backed woodpecker, *Chrysocolaptes lucidus*, of which there are no fewer than six well-defined races differing in colour.

These islands are the home of the magnificent monkey-eating eagle, *Pithecophaga jefferyi*, first discovered by John Whitehead. They are specially rich in pigeons, cuckoos and kingfishers, the last ranging from the rather ungainly stork-billed kingfisher to the brilliantly coloured woodland species barely five inches in length. The Philippines are considered a sub-region of the Oriental region; but a part of the Archipelago, the Palawan group, belongs to the Malaysian sub-region. The birds of this group are treated in a separate appendix, and one of the most striking is the Palawan peacock pheasant, *Polyplectron emphanum*, which belongs to a genus not represented in the Philippines proper but ranging from Borneo to the Eastern Himalayas.

The authors have considered it necessary to suppress some well-known genera. They do not recognize the genus *Squatarola* and treat it as a synonym of *Pluvialis*, since they do not think the absence of the hind-toe in the grey plover is sufficient to place it in a separate genus from the golden plover. Had they studied Lowe's papers they would have learnt there are other differences which make a good case for keeping the two genera. It is unfortunate, too, that many well-established English names have been changed because the authors consider them unsuitable. Among others the common kingfisher becomes the river kingfisher, Swinhoe's snipe the marsh snipe, and the black-necked tailor-bird the common tailor-bird. All rather confusing for the amateur ornithologist who visits different parts of the East.

N. B. Kinnear

A RUSSIAN REVIEW OF BONDS IN CHEMISTRY

The Chemical Bond and the Structure of Molecules

(In Russian.) By Ya. K. Syrkin and M. E. Dyatkina. Pp. 588. (Moscow and Leningrad: State Scientific-Technical Publishing House of Chemical Literature, 1946.) 30 roubles.

The authors of this work, who in recent years have been making important contributions to the study of resonance, the diradical state, polarity in the hydrocarbon series, and the structure of the boron hydrides, are probably the best-known Russian workers in the field of quantum chemistry. The book is intended to fill the gap which has apparently existed in Russian chemical literature by reason of the absence of books comparable with the standard British and American treatises on the theory of the chemical bond and wave-mechanical conceptions of valency. It covers broadly the ground of Pauling's "Nature of the Chemical Bond", but in addition presents the mathematical foundations of quantum mechanics (Schrödinger's method), the detailed Heitler–London treatment of molecules, and the mathematical point of view in general; for the authors consider that the student can achieve the critical attitude essential for progress in this field only by becoming thoroughly acquainted with all the postulates, limitations and approximations involved in the deduction of the equations which he will use.

After a description of the principles of the electronic configurations of atoms, which includes an introduction to the conception of wave functions, there follows a wave-mechanical study of the hydrogen molecule ion, the hydrogen molecule, and the homopolar bond. The subjects of directed valency bonds, resonance, the method of molecular orbitals, infra-red and Raman spectra, dipole moments, bond energies, intermolecular forces, the crystalline state, complex compounds, and the structure of the boron hydrides are presented against a background of experimental data, and controversial matters are critically discussed. Quite recent work is reviewed; for example, Longuet-Higgins and Bell on B_2H_6 (*Proc. Roy. Soc.*, A, 183, 357; 1945).

The last three chapters (pp. 480–569) are entirely mathematical and deal with the three-electron problem (Slater's method), the calculation of resonance energy, and miscellaneous problems.

There are author, formulæ and subject indexes. The book appears to be more comprehensive and up to date than any single volume on the chemical bond at present available in the English language.

G. Stanley Smith

The Milky Way

By Bart J. Bok and Priscilla F. Bok. (Harvard Books on Astronomy.) Second edition. Pp. vi+224. (London: J. and A. Churchill, Ltd., 1946.) 18*s*.

WRITERS on astronomical subjects find it comparatively easy to give a popular or semi-popular description of such a parochial affair as the solar system, but not so easy to provide a similar description of the Galaxy. The book under notice is undoubtedly the best of the semi-popular type that has been produced on this subject, and it presents the reader with an excellent account of the methods used to explore the Milky Way and to fathom some of its secrets. Here we have descriptions of the means by which astronomers ascertain stellar distances, masses, sizes, temperatures, etc., and most of these can be easily understood by those who have little or no background in mathematics or physics. They will read the interesting story of our Galaxy—just one of millions—the longest axis of which is more than 100 million light-years, the number of stars probably exceeding 100,000 million. Some of these stars are so large that the sun could be placed at the centre, and the orbit of Mars would lie well inside their outer layers, while the whole system is moving around its centre, the speed of the sun being 150 miles a second and the time required to complete a revolution 200 million years.

It must not be assumed that all the secrets of the Milky Way have been laid bare; so much still remains to be done that it would be true to say that our knowledge of the Galaxy as well as of the extragalactic systems is very limited, and many years of patient research will be necessary before it is possible to settle a number of controversial points. Readers of this book will probably form the opinion that far more remains to be done than has yet been accomplished.

The work is illustrated with ninety-three figures, two of which are large-scale photographic maps of the Milky Way and thirty of celebrated astronomers whose investigations have been responsible for advancing our knowledge of the Galaxy.

M. DAVIDSON

Field Archæology

By R. J. C. Atkinson. Pp. x+238+8 plates. (London: Methuen and Co., Ltd., 1946.) 12*s*. 6*d*. net.

IT is all to the credit of British archæology that its technique of field-work and excavation should have been built far less from theoretical principles than from practical experience, won gradually in the field itself by the men and women on the job. But matters have latterly been coming to a point where the fruits of this experience required gathering together, for the benefit both of beginners and indeed of the men and women on the job themselves. Mr. Atkinson's book meets this requirement admirably. A little more than two hundred pages long and of convenient pocket size, it is exactly suited to the part of archæologist's 'companion', in which it should be assured of a long career of usefulness and many editions.

The author is still young, but he writes throughout from personal knowledge of what he is discussing, gained mainly in the region of Oxford, where he is now assistant keeper of antiquities in the Ashmolean Museum. True, workers in the regions of sterner physique in the north and the farther west may here and there have things to add; but the book abounds so richly in practical information and quietly shrewd advice that it is really indispensable for anyone pursuing out-of-door archæology, no matter where, nor whether professionally or as a constant or occasional hobby. Field-work and excavation, surveying, recording and photography, interpretation of evidence and the preparing of reports for publication are all treated thoroughly yet simply, and the plates and the author's diagrams are altogether excellent.

C. F. C. HAWKES

Plastics Applied

Being a Survey of Patent and Technical Literature with Collected Data of Interest to Users of Plastics in all Branches of Industry. Edited by Dr. V. E. Yarsley. Second edition. Pp. 528+lvi+8 plates. (London: National Trade Press, Ltd., 1946.) 42*s*. net.

THIS handsome volume represents the present stage in the development of plastics in so far as applications are concerned. Naturally, therefore, one would not expect to find a great deal relating to fundamental research. After an introductory review, a good account of the numerous uses of plastics in industry follows. Indeed the range is amazing: shipbuilding, photography, textiles, insulation, to mention but a few of the actual or potential uses. There are two chapters on welfare and safety problems, which will be welcome, and, at the end, a number of useful tables.

Two points of wide interest may be singled out; one is that with so much replacement to do in all branches of national life, the opportunity (and responsibility) for good design should be fully realized by manufacturers; the other stresses the manifold possibilities which occur in starting with substances almost universally colourless. The implication is that almost every conceivable hue should be within the grasp of designers and artists.

The compilers have managed to produce a book obviously suitable for consultation in the office and factory which is, at the same time, dignified and appropriate as a work of reference.

F. I. G. R.

A Bibliography of Statistical Quality Control

By Grant I. Butterbaugh. (Published for the Bureau of Business Research of the College of Economics and Business.) Pp. viii+114. (Seattle, Wash.: University of Washington Press, 1946.) 1.50 dollars.

STATISTICAL methods of controlling quality of output have now been tried out in many branches of industry, the War in particular having provided a strong impetus with its demand for large-scale fine-quality production. The literature of the subject has become bulky, and contains records of interesting ideas and extensive practical experience (together with, unfortunately, much wearisome repetition of the same first principles). This bibliography covers literature published up to 1945. Most of the entries are followed by a brief synopsis or a reference to published reviews. The compilation has been made carefully, and will be of service to many "statisticians, teachers, students and businessmen directly responsible for quality control". It is a pity that a subject index has not been included, but the book is not too large to be read completely by anyone searching for particular applications. The theory of quality control is developing rapidly, and it is to be hoped that up-to-date editions of the bibliography will be available at not too long intervals.

F. J. ANSCOMBE

THE EXPLORATION OF ANTARCTICA*

By Dr. BRIAN ROBERTS
Scott Polar Research Institute, Cambridge

THE sudden widespread interest in the Antarctic, aroused by the announcement that no less than twelve nations are organising expeditions to that region, has resulted in a spate of articles which has been chiefly remarkable for inaccurate rumours and speculations. Supposed rich deposits of uranium and other valuable minerals have been depicted as the prize for the winners of an international race to stake out territorial claims. It may therefore be useful at this stage to record the present position with regard to sovereignty and territorial claims, to summarize briefly what is known about Antarctic economic resources, and to add some notes about the various expeditions which are now either planned or in operation.

Sovereignty and Territorial Claims in the Antarctic

There are three areas of British territory in the Antarctic continent, administered by the Governments of the Colony of the Falkland Islands, New Zealand, and Australia, respectively. The Falkland Islands sector consists of the Falkland Islands Dependencies as defined by Letters Patent of July 21, 1908, and March 28, 1917. The New Zealand sector, known as the Ross Dependency, was defined by an Order in Council of July 30, 1923. The Australian sector, known as the Australian Antarctic Territory, was defined by an Order in Council of February 7, 1933.

Adélie Land, a French *enclave*, lies within the Australian Antarctic Territory. It was annexed by France by a decree of April 1, 1924.

Queen Maud Land came under Norwegian sovereignty by a decree of January 14, 1939.

The Pacific sector between the Falkland Islands Dependencies and the Ross Dependency has been partially claimed by the Chilean Government; but no Chilean expedition has ever visited this region. A Chilean decree of November 6, 1940, defined the sector between long. 53° W. and 90° W. as Chilean territory.

Since 1939 the Argentine Government has been pursuing an increasingly active policy to extend its earlier claim to the South Orkney Islands to the whole of the Falkland Islands Dependencies between long. 25° W. and 68° 34′ W. It will thus be noted that the Chilean and Argentine claims not only overlap with each other but also conflict with the British claim to the Falkland Islands Dependencies.

Finally, although United States citizens have laid claim to various regions in the Antarctic since Admiral Byrd's first expedition in 1928–30, the United States Government has never made any territorial claims in the Antarctic. So recently as December 27, 1946, Acting Secretary of State Dean Acheson repeated that his Government has not recognized any claims of any other nations in the Antarctic and has reserved all rights which it may have in those areas.

Economic Resources

Antarctic lands are barren, with little immediate prospect of any discoveries of minerals of commercial significance. Antarctic seas, however, support an extremely rich fauna, and for forty years the whaling industry has produced great profits. There is also a small but flourishing industry in seal oil. Apart from these, almost nothing is known about the economic resources of the region.

Low-grade coal or carbonaceous shales have been located in the Beacon Sandstone formation at Mt. Buckley, at the head of the Beardmore Glacier; at Granite Harbour in Victoria Land; in the Queen Maud Range; and at Horn Bluff in King George V Land. The reserves are probably large, but the samples examined are charred by volcanic action; and all the sites except Horn Bluff are far inland and inaccessible. Very small quantities of gold and silver have been found at Cape Denison in the Australian Antarctic Territory. Cassiterite (tin ore) has also been found in the Australian Antarctic Territory. Galena (lead ore) and pyrites (iron sulphide) have been found far inland in Marie Byrd Land in the Pacific Sector. Iron pyrites and copper ore have been found in the South Shetland Islands and Palmer Archipelago in the Falkland Islands Dependencies. All these occurrences have been insignificant. In short, nothing has yet been found of sufficient value to make exploitation worth while at such great distances from any market. It is scarcely necessary to add that no radioactive minerals or oil have been discovered in any part of the Antarctic. On the other hand, Antarctica is a continent of approximately six million square miles. Although most of this area is covered by an ice sheet, there are innumerable outcrops of accessible rock, and it would indeed be surprising if a sufficient search did not disclose mineral resources.

Expeditions

British. In 1943 the Colonial Office made arrangements to resume scientific and survey work in the Falkland Islands Dependencies. This programme, which was started during the War, has since been put on to a peace-time footing, and the organisation has been named the Falkland Islands Dependencies Survey. It is planned that this work in the land areas of the Dependencies will supplement the investigations carried out by the "Discovery" Committee and other British expeditions before the War.

In February 1944, parties, led by Lieut.-Commander J. W. S. Marr, R.N.V.R., were established at Port Lockroy in the Palmer Archipelago (Base A: ten men) and at Deception Island in the South Shetlands (Base B: four men). An attempt to establish a third base at Hope Bay in Trinity Peninsula was frustrated by adverse ice conditions. Two ships were employed: H.M.S. *William Scoresby* and *Fitzroy*. It was officially announced in the Press on April 24, 1944, that arrangements had been made to resume scientific and survey work in the Dependencies, and that fully equipped bases had been established. For security reasons, however, no information could be given during the War about the locality of the bases.

In the southern summer of 1944–45 three ships were employed: H.M.S. *William Scoresby*, *Fitzroy* and *Eagle*. A third base was established at Hope Bay (Base D) in February 1945, and four men were again left at each of the first two bases. A further hut was erected at Sandefjord Bay on Coronation Island in the South Orkneys. Commander Marr had to return to England owing to ill-health, and the command of the expedition was given to Captain A. Taylor, R.C.E. Dog teams and sledging equipment

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* This article was accepted on January 22; it therefore takes no account of later developments.

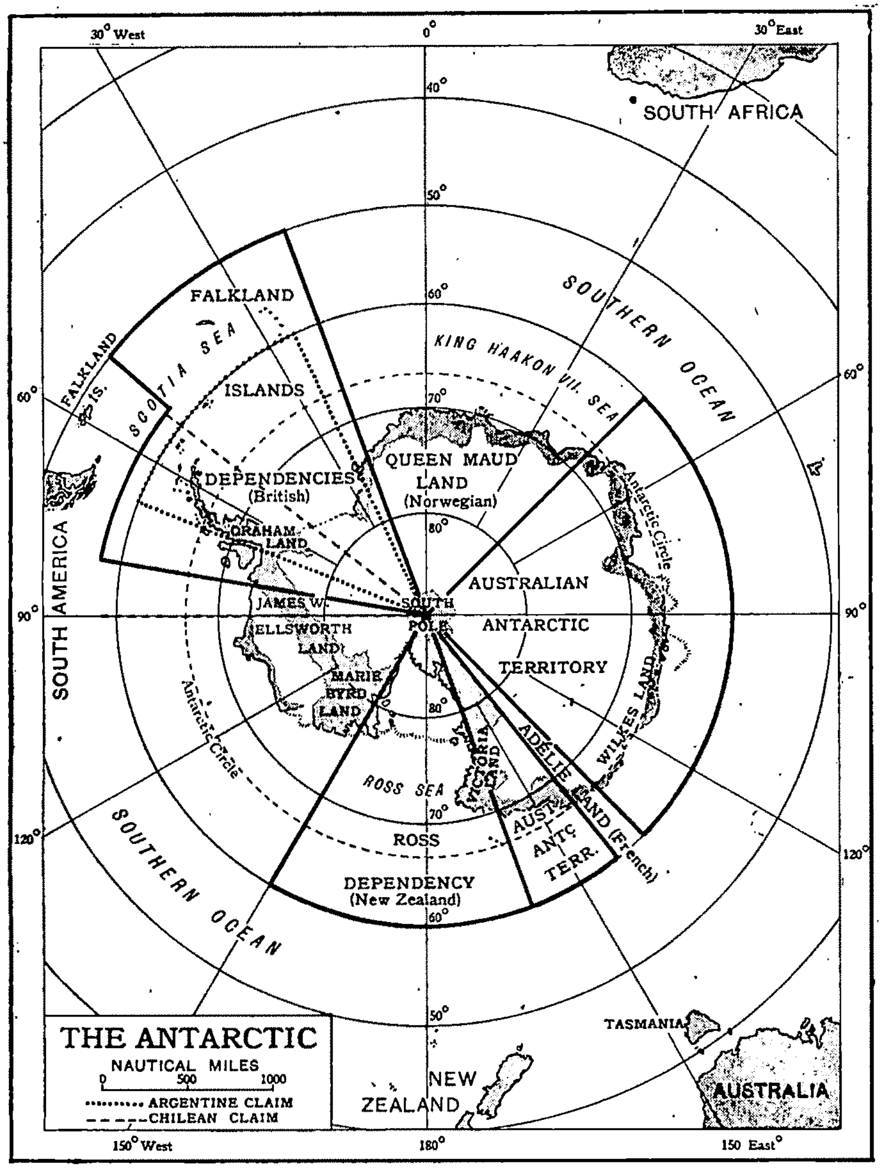

FIG. 1. THE ANTARCTIC SHOWING VARIOUS TERRITORIAL CLAIMS. SHADED AREAS HAVE BEEN ACTUALLY SEEN BY EXPLORERS

enabled the party at Hope Bay to sledge southwards during 1945, surveying James Ross Island and the mainland coast southwards to Cape Longing.

In December 1945 relief parties were sent out under the command of Surgeon-Commander E. W. Bingham, R.N. *Fitzroy* and H.M.S. *William Scoresby* were again employed, and a new ship, *Trepassey*, built in Newfoundland especially for ice work, made possible a more extended programme. Eight men were left at Hope Bay, and four each at Deception Island and Port Lockroy. New bases were established at Cape Geddes on Laurie Island in the South Orkneys (Base C: four men), and at Neny Fjord in south-west Graham Land (Base E: ten men). The old huts of the British Graham Land Expedition of 1934–37 at the Argentine Islands and Debenham Islands were repaired for the use of the Falkland Islands Dependencies Survey. A further supply of dogs and sledging equipment enabled the parties at the two mainland bases to carry out a series of survey journeys.

Meteorological stations are maintained at all these bases, and an investigation is being carried out into the possibilities of weather forecasting in the South Atlantic with particular reference to the development and movement of Antarctic depressions. Extensive geological and biological collections have been made, and the whole project has been planned with the view of making a systematic study of all aspects of the Falkland sector of the Antarctic. In December 1946 relief parties were again sent out from England in *Trepassey*, and it is this routine relief which has been incorrectly reported as a new British expedition.

A feature of the Falkland Islands Dependencies Survey has been that of Commonwealth and Empire co-operation with the United Kingdom. The staffs of the shore stations have included men from Australia, Canada, New Zealand, South Africa, Rhodesia and the Falkland Islands, while the crews of the *Eagle* and *Trepassey* came from Newfoundland. The Falkland Islands Dependencies Survey acts under the authority of the Governor of the Falkland Islands and the general direction of the Colonial Office with the co-operation of the Scott Polar Research Institute and the "Discovery" Committee.

No other activities originating in the United Kingdom are at present in progress in the Antarctic. The "Discovery" Committee's organisation and work in England are continuing, and it is possible that the Committee's ships will be re-commissioned.

United States. Two American expeditions will be working in the Antarctic this season, one sent out by the Navy Department under the command of Rear-Admiral R. E. Byrd and the other led by Lieut.-Commander Finn Ronne, backed by the American Geographical Society and other private organisations.

The Navy Department expedition was officially announced on November 12, 1946, and is the largest operation ever planned in the Antarctic. The objectives of the expedition are stated by the Navy Department to be (*a*) "training personnel and testing equipment in frigid zones", (*b*) "consolidating and developing the results of the U.S. Antarctic Service Expedition of 1939–41", (*c*) "developing naval techniques for establishing, supporting and using bases

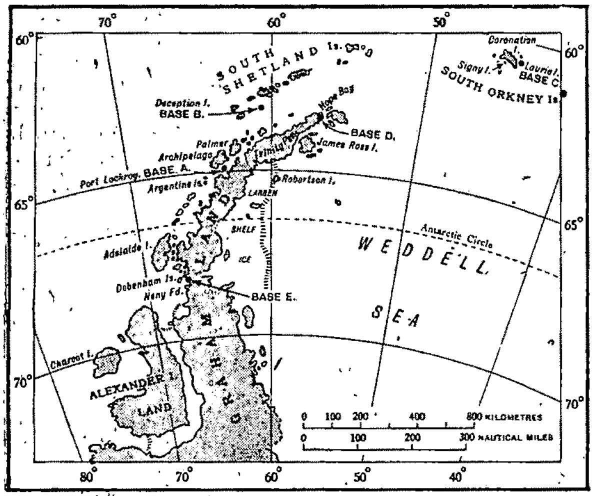

FIG. 2. BASES OF THE FALKLAND ISLANDS DEPENDENCIES SURVEY

under comparable conditions", and (*d*) "amplifying knowledge of the area with respect to hydrographic, geographic, geological, meteorological and electromagnetic propagation methods". For this purpose a task force of the Atlantic Fleet, augmented by units of the Pacific Fleet, has been assigned to the Antarctic during the navigable season of 1946–47. Technical control of the expedition is being exercised by Rear-Admiral Byrd, who is on duty in the Office of the Chief of Naval Operations as adviser on Arctic and Antarctic matters, and who is accompanying the task force. The commander is Rear-Admiral Richard Cruzen, who was Admiral Byrd's second-in-command in the 1939–41 expedition.

The task force has been divided into three main groups. The Central Group includes the flagship and headquarters communication ship, U.S.S. *Mount Olympus*, the Coast Guard icebreaker U.S.S. *Northwind*, Navy icebreaker U.S.S. *Burton Island*, the cargo ships U.S.S. *Yancy* and U.S.S. *Merrick*, and the submarine U.S.S. *Sennet*. The East Group is under the immediate command of Captain George J. D. Dufek. It includes the seaplane tender U.S.S. *Pine Island*, the oiler U.S.S. *Canisteo*, and the destroyer U.S.S. *Brownson*. The West Group is under the immediate command of Captain Charles A. Bond. It includes the seaplane tender U.S.S. *Currituck*, the oiler U.S.S. *Cacapon*, and the destroyer U.S.S. *Henderson*.

It is not intended that any of these ships should remain in the Antarctic during the southern winter, but a shore base capable of supporting a small party for at least eighteen months will be established, possibly on the site of Admiral Byrd's former base at 'Little America' on the Ross Shelf Ice, "to provide against contingencies". Aircraft for shore-based flight operations will be flown in from an aircraft carrier after this base has been set up. Each of the two large seaplane tenders carries three camera-equipped Martin Mariner patrol seaplanes, a small scout plane and two helicopters. Each of the two icebreakers carries one scout seaplane and one helicopter. Long-range operational and mapping flights are to be made by the Mariners, while the scouts will be used mainly for short-range ice reconnaissance and the helicopters for rescue work in case of forced landings.

While the purposes of the operation are described as primarily of a military nature (that is, to train naval personnel and to test ships, aircraft and equipment under polar conditions), the expedition will afford an unequalled opportunity to collect scientific information. To take full advantage of this, arrangements have been made for a number of scientific workers to participate under the general guidance of the Director of Naval Research, Rear-Admiral P. F. Lee. The Weather Bureau, Coast and Geodetic Survey, Coast Guard, the U.S. Geological Service, the Hydrographic Office, the material bureaux of the Navy Department and other Government scientific agencies have provided meteorologists, geographers, oceanographers, hydrographers, photographers, etc. The Army will be represented by air and ground force observers and by quartermasters interested in clothing and rations. The Marine Corps has furnished a part of the air flight crews and other cold-weather specialists. Altogether, approximately 4,000 officers and men are taking part in this gigantic expedition.

Thirteen vessels of the task force sailed from United States ports on December 2, 1946. It was announced that the eastern group would go to Peter I Island and would work eastwards round the continent. The western group would head for a point south-west of New Zealand and follow the coast of Antarctica westwards. The central group would head for the Ross Sea.

Commander Finn Ronne plans to visit the west coast of Graham Land and has announced his intention of establishing a base in Marguerite Bay, where his party of twenty men would spend the winter. The Diesel-powered wooden ship *City of Beaumont*, formerly known as *Navy ATA—215*, has been lent to the expedition by a special Act of Congress and should reach the Antarctic by mid-February. The expedition is equipped with three aircraft. Commander Ronne plans to re-occupy the old "East Base" huts of the American Antarctic Service Expedition of 1939–41, which are on the same small island as the southern base of the Falkland Islands Dependencies Survey. The situation which may arise from two independent and unco-ordinated expeditions based within 200 yards of each other will not be without difficulties.

Argentina. In November 1946 the Argentine Government made known its intention to establish "a permanent meteorological observatory" to complement the one it has for long maintained in the South Orkney Islands. On December 20 the Argentine Press announced that the naval transport *Patagonia* would shortly be sailing for the Antarctic. The vessel sailed from Buenos Aires on January 4 and will be assisted by three other ships—the transport *Chaco*, the oil tanker *Ministro Ezcurra*, and a whale-catcher. The expedition, which is equipped with an amphibian aircraft, is carrying a relief party for the existing Argentine meteorological station at Scotia Bay on Laurie Island in the South Orkneys. It is stated that the expedition "intends to explore the Antarctic sector of Argentina", as far as 74° S. (that is, the west coast of Graham Land), returning home at the end of March. It was confirmed that the expedition is also to establish a new Antarctic meteorological station and to "reaffirm Argentina's claim to sovereignty over the entire zone lying between the Argentine mainland and the South Pole". An Argentine wireless news bulletin of January 3 stated that a Chilean naval officer would accompany the expedition, reciprocating the gesture of the Chilean Government in including Argentine officers in its expedition.

Chile. On December 14, 1946, the Chilean Foreign Office announced that preparations were being completed to send the frigate *Iquique* and the transport *Angamos* of the Chilean Navy to Antarctica "to establish contact with that most remote corner of the national territory and to determine on the spot all of the possibilities it offers to the country". This statement confirmed that two Argentine naval officers would go with the Chilean expedition to "the American sector of Antarctica" (that is, the sector facing the tip of South America), and concluded that the Government was "taking the greatest interest in the distant Antarctic zone, considering that it forms a prolongation of the soil of the motherland and that it contains important resources for the national economy". Later unconfirmed reports from Chile state that this expedition consists of three ships which will all return to Chile in March 1947.

Australia. Sir Douglas Mawson has for long been advocating the establishment of a permanent research station on the Antarctic coast south of Australia. In 1939 the *Wyatt Earp* was purchased by the Commonwealth Government with the view of transporting scientific parties to the Australian Antarctic Territory. The War necessitated postponement of these plans, and it has not yet been possible to recondition the *Wyatt Earp* after her war-time coastal patrol work. On December 20, 1946, it was announced that the Australian Cabinet had decided to send a naval vessel, equipped with a suitable aircraft, on a short reconnaissance voyage to the Antarctic this season to locate a suitable site for a base to be occupied next year. It was also stated that the Commonwealth Government would proceed immediately with plans for the exploration of the Australian Antarctic Territory. A later announcement, however, indicates that this reconnaissance expedition will not take place this season.

New Zealand. On December 28, 1946, Mr. Peter Fraser made a statement about the official New Zealand attitude. The New Zealand Government, he said, had no desire to send any expedition to the Antarctic ahead of that led by Admiral Byrd for the purpose of asserting sovereign rights in the Ross Dependency. It had been hoped for some time to extend scientific work in the Antarctic, but the War had made this impossible. A departmental committee was investigating the practicability of establishing a permanent scientific station in the Ross Dependency, and the dispatch of an expedition next year would be considered when the examination was completed. New Zealand hoped to co-operate with the United Kingdom and Australia in an international plan of Antarctic research: details of which were still under discussion. The Americans were welcome to fly over New Zealand territory.

South Africa. In 1944 a South African Antarctic Research Committee was formed on the initiative of the Geological Society of South Africa at Johannesburg. This Committee has for more than two years been actively considering the possibility of a South African Antarctic expedition and has been in close touch with those in the United Kingdom who are interested in similar projects. The suggestion has been put forward that a South African expedition should establish a base in Coats Land. General Smuts has advised the Committee that the South African Government would not be likely to support the project unless other nations showed interest in a joint scheme. The Committee continues its investigations, and, as a start, has accepted an offer to send a South African geologist to join the staff of the Falkland Islands Dependencies Survey.

International Expedition. Plans for a British–Norwegian–Swedish expedition to the western part of Queen Maud Land are being discussed. The area to be investigated was photographed from the air by the Germans in 1938–39 and was named by them Neu-Schwabenland. The German maps and photographs reveal a remarkable area of ice-free land which offers a field for research of the first scientific importance. British participation in this expedition is being discussed by a joint Committee of the Royal Geographical Society and the Scott Polar Research Institute. It is proposed that this expedition shall be purely scientific, and it is unlikely to start before 1948 or 1949.

Whaling expeditions. The Antarctic whaling season opened on December 8, 1946, and extends to April 7 next. In view of the present world food shortage, the results will be awaited with more than usual interest. Whale oil is used in the margarine and lard compound industry and for making soap; important by-products are fertilizers and animal feeding stuffs.

The 1945–46 whaling season was disappointing, due mainly to bad weather and the unpreparedness of the principal fleets. The total oil production was only 820,883 barrels, compared with 2,820,771 barrels in 1938–39. This season fifteen floating factories with their fleets of catchers have sailed for the Antarctic, comprising seven from Norway, three from the United Kingdom, one from South Africa, one from the Netherlands, one from the U.S.S.R., and two from Japan—the last despite protests from other participants owing to that country's failure in the past to observe the restrictions imposed by the International Whaling Convention. This is the first occasion upon which the Netherlands and the U.S.S.R. have undertaken whaling in the Antarctic. Apart from the three land stations at South Georgia, all these whaling expeditions will be operating at sea, mainly outside territorial waters.

The post-war regulation of whaling was considered at an international whaling conference held in Washington last November. The short-term need for oil and the long-term need to preserve the stock of whales are difficult to reconcile; but it is generally agreed that the stock must be protected by a total limit to the Antarctic catch. Although the total catch must be shared by a number of nations, it is not expected that this will be a source of international dispute at the present time.

The news of all these expeditions has failed to evoke the expressions of pleasure and interest from foreign countries which formerly accompanied such enterprises. The Russian Press has charged the United States with prospecting for uranium in order to increase their stock of atomic bombs. The Argentine and Chilean Press have complained that the British and American expeditions are equivalent to a trespass on their national territories. American, British and Dominion newspapers speculate on the race for uranium and other minerals, and emphasize the political rivalry which is accompanying the partition of the last continent.

It is a sad reflexion on current political psychology that such claims and charges should invade a field which was once characterized by international courtesy and goodwill. What is now happening is the realization on the part of all concerned that the economic development of this frozen continent is technically within sight—providing there is anything there which is worth the trouble of development. The political question which is now beginning to arise—well in advance of any economic necessity—is by whom, and in what way, development is to be undertaken. There is room enough and to spare in Antarctica to absorb all the energy and enterprise which can be devoted to it. The greater part of the continent is still unexplored, and there are countless unsolved problems awaiting investigation. This task of exploration is essentially one that demands international co-operation. While official interest is now undoubtedly solving the greatest difficulty of earlier explorers, namely finance, the hurried preparations for most of the present expeditions can only result in much wasted effort. Moreover, friction is almost unavoidable when two or more expeditions plan, without prior consultation, to operate in the same area.

The Colonial Office has made it clear that it will always welcome foreign co-operation in the exploration of the British territories in the Antarctic which are administered by the Falkland Islands Government. It is impossible, however, to arrange co-operation between expeditions which keep their plans secret until they sail. In Great Britain provision exists for international co-ordination in the Scott Polar Research Institute and the Royal Geographical Society, which have recently set up a joint Antarctic Research Committee. Mention has already been made of the similar Committee which has for some time been in existence in South Africa. When the British Empire Scientific Conference met at Cambridge in June 1946, useful preliminary discussions about Antarctic exploration and research took place at the Polar Institute. The foundations have been laid for maintaining closer contacts and for training Dominion research workers in polar techniques in the Falkland Islands Dependencies. It is to be hoped that this co-operation will be developed to the fullest possible extent.

THE MISSION OF THE UNIVERSITIES

By J. MACKAY-MURE

RECENT events have resulted in strong pressure on the universities to increase the number of students. The Barlow Committee, in recommending that the present output of university scientific workers should be doubled "at the earliest possible moment", expressed the hope that there might be a similar increase in the number of arts students. The Clapham Committee urged a large increase in the provision made by the universities for teaching and research in the social sciences. It is, however, extremely doubtful whether the existing universities are in a position to double their output of students within the next ten years without surrendering their essential character and independence. As the universities expand they will have to recognize that the great bulk of their funds, both for purposes of income and of capital expenditure, can only come from the Government, and there is a growing nervousness lest the Government, which is now paying the piper to the tune of £9,000,000 a year, will soon want to call the tune.

While it is undoubtedly true that the universities are facing an organisational crisis, brought about by the pressure of new demands for trained personnel, this is less than the whole truth. They are also facing a crisis about themselves and their function in society. Because the genuine freedom of a university is created from within and can only be destroyed from within, academic freedom is, or ought to be, more than a tradition of the universities. The necessity for it has, unhappily, tended to be obscured in recent years by the importance which has been attached to the teaching function of a university. If too much emphasis has been placed on this and other activities which it is right and proper that a university should, in certain circumstances, pursue, too little attention has been paid to those which it has a bounden duty to pursue at all times and under all conditions. The modern doctrine that the primary function of a university is to supply experts in the spheres of science, business, administration, and the social sciences can become both dangerous and heretical—not because it advocates any single thing which ought not to be done, but because it represents an idea of a university which is out of focus. It thrusts into the background that conception of it as a centre of cultural life and cultural progress which makes freedom not merely desirable but a first essential. Without freedom such a centre ceases to be a university, a community of scholars within which every man may open his mind to a total engagement in the struggle for truth.

The maintenance of this freedom has to-day acquired a new significance. As the State system of education is reformed and developed, there is the assurance of that technical and vocational training on which the efficiency of the community depends. But the quality of the community depends primarily on its standards and its ideals, on the defence and promotion of fundamental values in life and progress. Although standards and values are by no means the monopoly of those who are brought into association with the life of a university, it is doubtful whether they can be maintained if the true idea of a university is allowed to decay. "It is not," says Plato, "the life of knowledge, not even if it includes all the sciences, that creates happiness and well-being, but a single branch of knowledge—the science of good and evil." Science, economics, and sociology provide the frame of contemporary society and satisfy its material needs, but "unless we have the knowledge of good and evil, their use and excellence will be found to have failed us".

Since nothing would be more disastrous than that the immensity of this issue should be made an excuse for pursuing a policy of *laisser-faire*, the decision of the General Council of the Student Christian Movement to call together a commission of senior members of the universities to help it "to consider the fundamental pre-suppositions of university education and their implications for the work of the S.C.M. in the post-war university" must be widely welcomed. As a result of the discussions of the commission, which met in 1944 and 1945, certain points of broad agreement emerged "in respect of (*a*) a criticism of the philosophy underlying modern university education; (*b*) the Christian reasons for supporting and defending with vigour a 'free' or 'liberal' university; (*c*) the essential beliefs necessary to maintain such a university; (*d*) the responsibilities of a Christian student in such a university". In order to get the matters with which the commission was concerned more widely discussed, the S.C.M. has now issued a series of twelve University Pamphlets[1] on different aspects of the problem.

By no one has the problem been more clearly stated than by Ortega y Gasset when he declared that the universities are "living below the demands of their time". "There is," to quote from his lively and stimulating "Mission of the University"[2], "no denying the fact that man invariably lives according to some definite ideas which constitute the very foundation of his way of life. . . . We are passing at present, despite certain appearances and presumptions, through an age of terrific *un-culture*. Never perhaps has the ordinary man been so far below his times and what they demand of him. Never has the civilized world so abounded in falsified, cheated lives. . . . Hence the historic importance of restoring to the university its cardinal function of 'enlightenment', the task of imparting the full culture of the time and revealing to mankind, with clarity and truthfulness, that gigantic world of to-day in which the life of the individual must be articulated, if it is to be authentic."

Accepting this diagnosis in "The Mind of the Modern University", Prof. John Baillie concludes that the present crisis can be traced to the failure of the universities to remain "closely integrated communities, inspired by a common purpose and cemented by certain common and firmly held convictions". This has led at the universities to a "refusal of definite commitments" and "the cultivation of a continued suspense of judgment". Although no man and no institution can live without a working basis of belief, Prof. Baillie naturally rejects the idea of coercing students to adopt any single philosophy of life. At the same time, he insists that it is a primary duty of a university to confront its members with the importance of possessing a clearly defined philosophy of life. Failure to do this is, he maintains, "an abnegation of the very purpose for which a university exists".

The magnitude and difficulties of this task are frankly faced by Prof. H. A. Hodges[3]. What is not, he says, sufficiently understood is that knowledge is a source of power. The universities are trafficking in a commodity the acquisition of which means power, and are caught in the same contradiction between professed aims and real desires as affects the whole of society. "The world has," he continues, "never been fuller of high hopes and high principles than in the last hundred years. The hopes have not been realized and the principles have been ineffective. Why ? Because there is a contradiction between the principles we profess and the desires by which we are actually moved. Our ideals, in which our conscious selves sincerely believe, are full of justice, humanity and peace. . . . But our imaginations, as reflected in art and literature, in popular amusements, and in our actual behaviour, are full of something else. Our admiration and emotional attachment go to power, and to knowledge as a source of power." Believing that this conflict between professed principles and effective archetypes is common to all contemporary social and political movements, Prof. Hodges finds no difference in this respect between liberal democracy of the Atlantic type and authoritarian communism on the Russian model.

Since this belief is held, in greater or lesser degree, by all the authors in this series, it is not surprising to find them also agreed in insisting that members of a university have, in Miss D. M. Emmet's phrase[4], a responsibility to focus "the intellectual conscience of the community". Nevertheless, she is emphatic that the first responsibility of a university, not only for its own sake but also for the sake of the community, is to *be* a university. "It should," she continues, "be a place where the criticism and evaluation of ideas is continually being carried forward ; where 'nonsense' can be exposed for what it is ; and where the 'intellectual virtues' of sincerity of mind are being fostered and transmitted."

Few, if any, will dispute Miss Emmet's conclusion that, within a totalitarian or purely utilitarian society, the university can only lose its soul or fight for it ; but neither she nor any of the other authors in the series is able to offer a positive solution of the immediate problem. The American expedient, recommended in the report of the Harvard Committee, is to provide students with 'integrating courses' designed to give a conspectus of knowledge or an introduction to some of the major issues of our time. But who are to be the integrators ? And are such courses, however good, more than an admission of the magnitude of the problem ? The sum total of human knowledge far exceeds the power of the human mind to contain it. The old unity of knowledge, or the belief that such a thing as truth about the whole system of things exists and can be found by human minds, is gone. But, however curricula may be devised and courses integrated, it is still possible for universities to be places in which real battles rage ; and, as long as the battles are concerned with fundamental issues and the combatants are fired with a determination to find a clearly defined philosophy, the universities will retain their cardinal function of 'enlightenment'.

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[1] Student Christian Movement Press, Ltd., 58 Bloomsbury Street, London, W.C.1. 1*s*. each. Full list of titles is contained in each pamphlet.

[2] Kegan Paul. 7*s*. 6*d*.

[3] "Objectivity and Impartiality." Pamphlet No. 2.

[4] "The Foundations of a Free University." Pamphlet No. 4.

ASTROLOGY AND ASTRONOMY IN THE SEVENTEENTH CENTURY

By JOSHUA C. GREGORY

ASTROLOGY was an integral part of astronomy and science from Ptolemy onwards. Many astrologers lived before A.D. 170, when Ptolemy flourished at Alexandria ; but he conveniently dates the beginning of an astrological fervour by giving the science a philosophy. Kepler dates the finish of the astrological vogue much less sharply, for the horoscopes only melted slowly out of seventeenth-century science. There were, of course, dissents during the long astrological grip on the best minds : they were active in the beginning and they were gathering towards the end. Astrology, however, as the history of science from Ptolemy to Kepler shows, is one firmly established and finally discarded hypothesis of science.

This is clear in Lynn Thorndike's six volumes, "A History of Magic and Experimental Science" (1923–41). Thorndike includes astrology under magic. Whether this is right or wrong, his exhaustive and valuable survey includes the astrological data. He begins with the first century A.D. and ends with the sixteenth. His history of this period, his occasional extensions into the seventeenth century, and many supplemental data, disclose astrology as an integral part of astronomy from Ptolemy to Kepler.

A modern astronomer who took fees for casting horoscopes would be legitimately suspected of deceiving victims who pay because they are deceived. A paragraph on the "Fourth Centenary of the Birth of Tycho Brahe", in *Nature*, Nov. 23, p. 740, suggests that earlier astronomers of those days earned a living by palming off horoscopes on the credulous; this ignores the persisting grip of astrological beliefs when Tycho Brahe and Kepler lived.

The Copernican system had an astrological part at first, though the movements of the earth, rather than the stellar motions, influenced destiny. When the "De Revolutionibus" was published on behalf of Copernicus in 1543, it was stripped of this astrology. Osiander's editing tried to soften any papal opposition to the new astronomy (Thorndike, l.c., 1941, **5**, 413f.). If the astrology was stripped off to assist the softening, an astrological astronomy deferred, in this instance, to possible papal protests against horoscopes.

Tycho Brahe does not surprise the historical sense by vindicating astrology, or by compiling annual predictions for the Court at Copenhagen, or by casting horoscopes for the royal family. Astrology was still rife when he died in 1601. Sir Francis Bacon accuses astrology of many errors; but he also exhorts science to reconstruct it justly.

Astrology is losing its grip in "The Anatomy of Melancholy" (1621), but has not yet lost it. Robert Burton seems to admit in one place that the stars are the most remote causes of "Heroical Love". In another he does not try to decide between astrological physicians and their opponents. He exclaims against the vanity of "genethliacal studies", but he notes that Saturn was lord of his geniture, that he had Jupiter in his sixth house, and that Mars had a hand in the matter. The stars do incline: Burton retains this astrological faith. They incline too gently, however, to compel those whom reason rules: he softens down the astrological power to decree or enforce. Christian astrology had frequently refused to place man's freedom at the mercy of the stars or planets. A prolonged powerful grip is perceptible in Burton's many references to astrological lore; his attempt to believe in astrology without believing too much suggests a loosening of the grip.

Sir Thomas Browne, in "Religio Medici" (1643), seems, somewhat ambivalently, to believe and disbelieve. No laborious argument against astrology is needed, for any truth it may have does not injure divinity. If astrology has any truth, Sir Thomas notes, he may "outlive a Jubilee". He does not "revolve Ephemerides and Almanacks in expectation of malignant aspects, fatal Conjunctions and Eclipses", but he does suspect a piece of the "Leaden Planet" in himself since he was born "in the Planetary hour of Saturn". In the "Pseudodoxia Epidemica" (1646), he does not condemn astrology as a popular error when he warns men against the pretentious astrologer who abuses the "worthy enquiry" of the stars. Satan also deceives men, Browne thinks, by "conceits of stars and meteors" other than "their allowable actions". In "Christian Morals", published in 1716 after his death, Sir Thomas commends the "celestial aspects" for admonition and advertisement, though they should not determine men's ways.

Bacon restricts "celestial operations" to "masses of things" and excludes the "calculation of nativities" from rational astrology. Burton and Browne obviously knew their own nativity horoscopes, and many others thought it at least prudent to know theirs. The degree of belief in the accuracy of the casting or in the horoscope when cast probably varied; but, as Browne hints, the horoscope might contain wholesome warnings. Any astrologer could conscientiously cast horoscopes under such conditions. The horoscope, precautionary or more trusted, did not necessarily involve an insistence on fatal necessity in the stars. The more prudent astrologers, Bacon admits, had always denied such fatal necessity.

The astrology which had prevailed widely among the intellectual élite since Ptolemy persisted pertinaciously. A Kepler who checks his own horoscope on the events of his own life, and, as Singer says, keeps in effect an "astrological diary", is historically quite intelligible. He is equally intelligibly an honest caster of horoscopes for the many who still believed in them—wholeheartedly or with varying qualifications.

OBITUARIES

Dr. F. F. Blackman, F.R.S.

FREDERICK FROST BLACKMAN was born on July 25, 1866, and died on January 30, 1947. His was a full life, which resulted in valuable contributions to botany, and to his University and College, of which he was a member for nearly sixty years.

His first published contributions to botany were two papers in the *Philosophical Transactions of the Royal Society* in 1895. They began a series entitled "Experimental Researches on Vegetable Assimilation and Respiration"; of which the twenty-first paper appeared in 1933. Only a few of the series bear Blackman's name, but all reveal the impress of his mind. They are a record of some of the investigations carried out by him and by the students working under his leadership. In all these researches he played an important part not only during the experimental work but also in marshalling the results for publication. In 1928 a new series commenced with three papers entitled "Analytic Studies in Plant Respiration". Other papers for this series have for some time been in a state which those with a less exacting standard than Blackman's would consider ripe for publication. These two series record the main field of his scientific activities. The views and discoveries he has already recorded have been so incorporated into the body of biological knowledge that their epoch-making character may be forgotten. It is a commonplace to elementary students that most of the gaseous exchange between leaves and the atmosphere takes place through stomata; but although this was suggested so long ago as 1832, it was much disputed until convincing experimental evidence was provided by Blackman in 1895. Whatever may be decided concerning the degree of generality of his Theory of Limiting Factors there is no doubt that the paper on "Optima and Limiting Factors", which he published in 1905, provided an outstanding clarification of biological thought and has had far-reaching effects. He was the last person to think that he had achieved finality in his formulations; as he liked to express it, he was making a first approximation to the truth, and he hoped it would pave the way for a closer approach. He was a pioneer in the application of precise quantitative methods in plant physiology and in the application of physico-chemical laws to the interpretation of biological processes. Yet he never failed to realize the complexities of the organisation of biological systems, and he retained his interest in these problems to the end.

Blackman's other major contribution to botany was the effect he had on those who had the privilege of listening to his lectures and on those who had the even greater privilege of doing research under his guidance. His lectures were masterly presentations of experimental results marshalled in such a way as to illuminate his theme. Much of the material was drawn from investigations made under his guidance, while that garnered from biological literature often appeared in a completely new form after having been subjected to his analytical mind. To experience to the full the discipline of his ways it was necessary to work on a problem under his guidance; his was a precise mind which gently indicated the right path. To see one's presentation of the results of an investigation analysed and then synthesized into a new form was indeed an education. He performed this service for many others who sought his advice.

Blackman was a member of the staff of the Cambridge Botany School from his appointment as demonstrator in 1891 until his retirement from the readership in botany in 1936, and as such he undertook a full share of the administrative work of the department. This, together with his wise advice, which continued after his retirement, contributed largely to its smooth running. He was a perfect colleague, and he had the gift of inspiring all, both staff and assistants, to give of their best. When the time came for the extension of the Botany School in 1933, he devoted as much thought to the planning of the new facilities as he had done to the running of the old department. He not only formulated his own requirements down to the smallest detail but also stimulated others to proceed in the same way.

When, in recognition of the active school which had developed under Blackman's inspiration, a Sub-Department of Plant Physiology was created in 1931 with the aid of a benefaction from the Rockefeller Fund, he naturally took charge, and but for complications of age and date of retirement he would have become the first professor of plant physiology in Cambridge. On relinquishing the readership his old students and associates presented him with his portrait, painted by Henry Lamb, which now hangs in the Botany School.

Elected a fellow of the Royal Society in 1906, he was awarded a Royal Medal in 1921, and gave the Croonian Lecture in 1923. He was president of the Botany Section of the British Association in 1908 and president of the Section of Plant Physiology at the International Botanical Congress held in Cambridge in 1930.

He devoted much time and thought to the affairs of St. John's College, of which he was steward for several years and in which he lived as a bachelor fellow until 1917. His advice on a wide range of subjects, including the preservation of old buildings, the erection of new ones, pictures, plate and many others, was sought and respected.

In 1917 he married Elsie Chick. They planned and built a house and surrounded it with a garden which gave them and their friends great pleasure, and provided opportunities for the exercise of his artistic and botanical interests. Mrs. Blackman and their son survive him.

Blackman had the same approach to all problems. He collected the facts and considered them carefully and dispassionately before giving his opinion. It was done so thoroughly and unobtrusively that there was a temptation not to notice the care that he had bestowed. He was as gentle as he was wise. To those who knew him well Blackman was a great man.

G. E. Briggs
F. T. Brooks

J. W. Sandström

Johan Wilhelm Sandström, meteorologist and oceanographer, who died in January 1947, was born on June 6, 1874. He was chief of the Meteorological Division of the Meteorological and Hydrological Institute of Sweden during 1919–39.

After leaving school, Sandström began life in a factory, but he came under the notice of I. Bendixson, professor of mathematics in the University of Stockholm. Bendixson managed to arrange that Sandström should have time off to go to lectures at the University. He took a keen interest in the promising young man, and the development of Sandström's mathematical talent was largely due to Bendixson's influence.

In 1898 Sandström became a pupil of V. Bjerknes, and his first substantial contribution to meteorology was a paper in the *Meteorologische Zeitschrift* (April 1902) on the "Relation between Temperature and Wind in the Atmosphere under Stationary Conditions", in which he applied to this problem a development by Bjerknes of Kelvin's classical paper of 1869 on vortex motion. Sandström arrived at the conclusion that in Europe, cyclones usually have a cold centre and anticyclones a warm centre, and he indicated the significance of the 'thermal wind', though he did not give it that name, which came nearly sixteen years later. He noted also, what has recently been rediscovered, that North American cyclones are in a much earlier stage of development than European cyclones.

Sandström next collaborated with Helland-Hansen in computing exhaustive tables for the application of Bjerknes' circulation theory to the currents of the ocean. He was also joint author with V. Bjerknes of the first volume of "Dynamic Meteorology and Hydrology", published by the Carnegie Institution of Washington in 1910—the first instalment of a treatise designed to present in an ordered and rational form the principles and development of meteorology and hydrography from the point of view of a mathematical physicist. The treatise was completed by the publication in 1932 of the magnificent three volumes on "Physical Hydrodynamics with applications to Dynamical Meteorology", in which V. Bjerknes had the assistance of J. Bjerknes, T. Bergeron and H. Solberg. But Sandström's help and encouragement had been outstanding and were fully recognized by V. Bjerknes, who acknowledged in the preface that without it he would scarcely have ventured on this great work.

Later in life, Sandström was occupied almost entirely with investigation into the Gulf Stream and its influence on climate. He was not content to use only theory and the observations of others: he made expeditions to test for himself the application of his theory. He prepared a very complete memoir embodying the results of his work. A part of this memoir is being printed by the Swedish Academy of Science and was in the press at the time of his death.

Sandström was a big, genial man. One of his colleagues describes him as a man "with a very vivid and vital interest in Nature and in the problems suggested by natural phenomena. His theoretical ability, which was combined with a good amount of common sense, was so much more remarkable as he was largely a self-educated man, having risen from the position of an aid in a mechanical factory to being the assistant and collaborator of scientists like Svante Arrhenius, Otto Pettersson and Vilhelm Bjerknes."

Meteorologists in England who knew Sandström either personally or through his writings will join with their colleagues in Sweden in mourning the loss of a great pioneer. E. GOLD

WE regret to announce the following deaths:

Prof. Louis Cobbet, formerly professor of pathology in the University of Sheffield, on March 10, aged eighty-five.

Major M. W. K. Connolly, an authority on the land mollusca of Africa, on February 26.

Prof. Llewelyn G. Owen, formerly professor of mathematics in the University of Rangoon, on February 23.

Mr. H. A. S. Wortley, principal of University College, Nottingham, on February 21, aged sixty-one.

NEWS and VIEWS

A Giant Sunspot

A GIANT sunspot group, one of the largest on record, crossed the sun's disk between March 3 and 17, with central meridian passage on March 10·2. Excepting one or two days, the prevailing cloudy skies gave little opportunity for detailed observations, but the following facts may be given. The maximum area of the group, consisting mainly of a pair of great spots, was 4,300 millionths of the sun's visible hemisphere. This exceptionally large area is less than that of the February 1946 spot (4,900 millionths) but greater than that of the July 1946 spot (3,950 millionths). The average area during disk passage of the present spot may, however, be less than that of the July spot (3,750) and is certainly less than that of the February spot (4,400 millionths). Two geomagnetic disturbances, not of great intensity, occurred while the present spot crossed the disk, namely, March 8–9 and March 15–16. Their provisional ranges at Abinger kindly communicated by the Astronomer Royal were

	D	H	V
1st storm	60′	270γ	220γ
2nd storm	30	150	120

The latitude of the spot group was 22° south, but the tilt of the sun's equator at this epoch of the year brought the group to within 15° of the centre of the disk at central meridian passage. Yet no great magnetic storm occurred about one day after central meridian passage, for which statistical results suggested a high probability. It is significant, however, that radio fade-out data, at any rate in Greenwich daylight hours, indicated that no intense solar flare (like those of February 6 and July 25, 1946) occurred when the spot was within the central half of the sun's surface turned towards the earth. Practically on the same solar meridian as the recent spot was another naked-eye group in latitude 13° north, and with maximum area about 1,400 millionths.

Effect of the Moon on Radio Wave Propagation

FROM time to time, some observational evidence has been forthcoming suggesting that the strength of signals received from radio transmitting stations over fixed paths is under certain conditions dependent upon the position of the moon at the time of observation. In particular, H. T. Stetson has investigated this matter, and in 1944 (*Terr. Mag. and Atmos. Elec.*, **49**, 9) described the results of the analysis of some eight years measurements taken at Boston on the strength of signals received from the Chicago broadcasting station. Contrary to his expectations, the evidence strongly indicated that the strength of the signals was dependent upon the age of the moon, although the effect was of a complex nature. It will also be recalled that in a paper published in 1939 (*Proc. Roy. Soc.*, A, **171**, 171), E. V. Appleton and K. Weekes showed the existence of a lunar tide effect in the height of Region E of the ionosphere. The tide was found to be semi-diurnal, with an amplitude variation of about ± 1 km. If these results are interpreted according to the simple theory of the formation of the ionized regions, they indicate a relative air-pressure oscillation several thousand times the measured relative pressure oscillation at ground level.

In a recent communication to the Editors, Mr. P. A. de G. Howell, 77 Glandovey Road, Fendalton, Christchurch, N.W., New Zealand, claims to have observed during 1938–39 and 1944–45, a correlation between the variation in long-distance transmission conditions at short wave-lengths and the phases of the moon. It was observed that there was a minimum of background noise and high signal strength with little tendency to fade for about two or three days on either side of full phase, these conditions changing to a maximum of noise with poor signals and fading around the time of new moon. The cycle of occurrences is easily confused with those associated with the solar period of similar duration, with which, however, it moves in and out of phase as the months progress. While both Dr. Stetson and Mr. Howell suggest that the effects are the result of changes in ionization in the earth's upper atmosphere, it is clear that the whole subject requires further investigation before definite conclusions can be reached as to the cause of the effect.

Population Trends and the World's Resources

DR. C. L. BERTRAM has presented in a minimum compass the main known facts of the relationship of population and human needs to the availability of animal and vegetable raw materials and foodstuffs (*Geogr. J.*, **107**, Nos. 5 and 6, May–June 1946). He accepts Carr-Saunders' estimates that the world's population has increased fourfold in the last three hundred years—from 545 million in 1650 to 2,057 million in 1933. Only Africa (100 million to 145 million) has failed to take part in this remarkable increase. Although probably three quarters of the world's people are farmers or their dependants, the majority of these do not get sufficient food to maintain health. Seventy-five per cent of Asia's 1,150 million people have a diet far below the standard for health: even the best-nourished countries, such as

Britain and the United States, had 20–30 per cent of the people suffering from malnutritional diseases before the War. The near-famine conditions now faced by the world are nothing new, but shortages are affecting those who, by their advantageous economic position, had previously been virtually immune from even the fear of famine.

Britain imports the largest quantity of food of any country in the world—in some cases as much in normal times as two thirds of the total of a given commodity entering into the world trade. If exporters are no longer compelled by economic needs to sell the food they badly need themselves, then the position is indeed difficult for the importers. The world position has been aggravated by that greatest scourge ever known to man—soil erosion—and the irrational over-exploitation of forests, fisheries and grasslands. The plea is made for policies based on real knowledge and quantitative data rather than half-knowledge or guess-work.

'Wellcome' Photographic Year Book

THE well-known 'Wellcome' Exposure Calculator, Handbook and Diary, published by Burroughs Wellcome and Co., has appeared in a modified form as the 'Wellcome' Photographic Year Book. The contents are similar, and those who made use of the original publication before the War will remember that it consists essentially of a diary, a number of pages ruled for recording the essentials of photographic exposures, a fund of useful photographic information, and a very useful exposure calculator. Used in conjunction with the illustrated examples of different types of subject, the calculator is one of the best of its kind. On the back of the exposure calculator, also in disk form, is a depth of field calculator with which the depth of field can be obtained for lenses of various apertures and focal lengths. The keen photographer will find the Year Book a valuable asset for the pocket.

Frank B. Jewett Fellowships: Awards

THE American Telephone and Telegraph Company, which founded the Frank B. Jewett fellowships for research in the physical sciences three years ago to commemorate the retirement of its eminent vice-president in charge of development and research, has announced seven awards for 1947–48. The purpose of the fellowships is to stimulate and assist research in the fundamental physical sciences, and particularly to provide the holders with opportunities for individual growth and development as creative scientific workers. The awards carry an annual stipend of 3,000 dollars to the holder and 1,500 dollars to the institution at which the recipient elects to do research. The awards are designedly post-doctorate, and only those who have recently received their doctorates or who are about to receive them are normally considered.

The awards for 1947–48 have been made to: (1) Dr. Martin G. Ettlinger (University of Texas and Harvard University), at present investigating the chemistry of cyclopropene and dicyclobutane derivatives at the California Institute of Technology as a Jewett Fellow for 1946–47; he intends to continue his present research studies. (2) Wallace D. Hayes (California Institute of Technology), who proposes to investigate problems of transonic and supersonic fluid flow. (3) Paul Olum (Harvard and Princeton Universities); he is to carry out research in algebraic topology. (4) Aadne Ore (University of Oslo), at present an F. E. Loomis Fellow at Yale University; he will work on the theory of combinations of electrons and positrons. (5) Dr. Alfred Schild (University of Toronto and the Carnegie Institute of Technology); he will study relativistic field theories in quantum mechanics. (6) Dr. Robert L. Scott (Harvard and Princeton Universities), at present Jewett Fellow, engaged in research in chemistry at the University of California; he is to continue his studies of the thermodynamics of solutions. (7) Edwin H. Spanier (Universities of Minnesota and Michigan), at present a Rackham Predoctoral Fellow at the University of Michigan; he will engage in research in the homotopy classification of continuous mappings.

British Iron and Steel Research Association: Appointments

MR. R. H. MYERS has been appointed head of the Steel Making Division of the British Iron and Steel Research Association and Dr. A. H. Leckie has been appointed deputy head. Mr. Myers studied under Profs. J. O. Arnold and A. MacWilliam at Sheffield, and, after a post-graduate course of one year, started his industrial career with the Midland Iron Company. Since 1930 he has been associated with research in the steel industry, as open-hearth officer to the Iron and Steel Industrial Research Council, in addition playing an active part in the Corrosion and Heterogeneity Committees set up jointly by the Research Council and the Iron and Steel Institute.

Dr. A. H. Leckie studied chemistry at University College, London, under Profs. F. G. Donnan and C. K. Ingold. After graduating, he was engaged in research for several years on molecular spectroscopy. In 1937 he joined the Technical Department of the British Iron and Steel Federation and was engaged on research on iron and steel works plant and principally on open-hearth furnaces. Dr. Leckie joined the British Iron and Steel Research Association, when that body took over the work of the Federation's Technical Department, and is in general charge of research work on furnace design and operation.

Radiocommunication Convention

THE Institution of Electrical Engineers is holding a Radiocommunication Convention during March 25–28, at which some seventy papers will be presented dealing particularly with war-time activities in this field and their resulting application to future peace-time development. The Convention will be opened on March 25 by Sir Stafford Cripps, President of the Board of Trade, after which Sir Stanley Angwin will give a lecture on "Telecommunications in War". On March 26 four meetings will be held dealing in turn with long-distance point-to-point communication, naval, military and aeronautical communication, and the special features of pulse modulation in communication systems. The subject of short distance communication will be dealt with during the following morning, while the afternoon and evening sessions of March 27 will be devoted to direction-finding and war-time broadcasting respectively. On the morning of March 28, Sir Edward Appleton will open the session on propagation with a paper entitled "The Investigation and Forecasting of Ionospheric Conditions". The afternoon of the same day will be devoted to radio components, and in the evening, Sir Clifford Paterson will conclude with a review of the Convention and the future trends of development indicated by the papers and discussions. At an additional meeting to be held on April 2, a number of papers will be presented dealing with the various types of continuous wave radio navigational aids which have been developed during recent years.

Summer School in X-Ray Crystallography

In recent years the study of materials by means of X-ray diffraction has come to occupy an important place in scientific research both in the universities and in industry. This field of study enters into physical, chemical, metallurgical, mineralogical and biological research. The necessary X-ray technique is, however, highly specialized, and for its proper understanding a fundamental training is required. An attempt to meet the demand for such courses was made at the University of Cambridge by the provision of Summer Schools in the years 1943–46. Although these schools were very successful, they are now to be discontinued; but, if the demand warrants, consideration will be given to their continuation at the Manchester College of Technology under the direction of Dr. H. Lipson. Correspondence should be addressed to the Director of Extra-Mural Studies, University, Manchester, 13.

Cambridge Summer School in Physical Chemistry

A Summer School on "Some Recent Advances in Physical Chemistry" will be held in the University Department of Physical Chemistry, Cambridge, during August 16–23 inclusive. A course of eighteen lectures will be given by the staff of the Department on the following topics: (1) molecular structure and valency theory (6 lectures); (2) chain reactions (6 lectures); (3) physics and chemistry of rubbing solids (6 lectures). Practical work on these topics will be arranged for those who desire it. Demonstrations will also be given and full opportunity provided for discussion with the lecturers and with those carrying out research in the laboratory. An inaugural lecture will be given on the evening of Saturday, August 16, and the course will finish on the evening of August 23. Arrangements have been made for most of those attending the School to be accommodated in colleges. Applications to attend the School must be received by May 1. Inquiries should be addressed to the Joint Secretaries, Summer School in Physical Chemistry, University Department of Physical Chemistry, Free School Lane, Cambridge.

Pasteur Exhibition

A Pasteur Exhibition will be held at the Science Museum, South Kensington, London, during April 10–May 26. The exhibition has been arranged and provided, with the assistance of the Cultural Relations Department of the French Foreign Office, by the Palais de la Découverte in Paris, where it has recently been on show. This institution is devoted to the exposition of modern science, employing for the purpose the most advanced techniques of visual education. The Pasteur Exhibition includes a chronological account of the chemical and biological work of Louis Pasteur on fermentation, putrefaction, the spontaneous generation of life, and on the causative organisms of numerous diseases of men, animals and plants. The results of his work are illustrated by panels dealing with pasteurization in the brewing and other industries, and the raising of disease-free silkworms. A section of the exhibition deals with the Pasteur Institutes established throughout the world for the preparation of serums and vaccines for the combating of disease epidemics.

Fourth International Cancer Research Congress

The Fourth International Cancer Research Congress will be held in St. Louis, Missouri, U.S.A., during September 2–7, 1947. The Union Internationale contre le Cancer having accepted the invitation of the American Association for Cancer Research, the Congress will be held under the joint auspices of these two organisations, with Dr. E. V. Cowdry, professor of anatomy, Washington University School of Medicine, and director of research of the Barnard Free Skin and Cancer Hospital, as president of the Congress. Of the three Congresses that have been held previously, the first was in Madrid, in 1933; the second in Brussels, in 1936; the third in Atlantic City, New Jersey, U.S.A., in 1939. The State Department in Washington having approved of the International Cancer Research Congress, official invitations will shortly be sent to foreign governments. Dr. M. G. Seelig, Barnard Free Skin and Cancer Hospital, St. Louis 3, Mo., is chairman of the Publicity Committee of the Congress.

An Optical-Acoustic Method of Gas Analysis

Mr. A. Whitaker, chief engineer of Ascot Gas Water Heaters, Ltd., Research Laboratories, Tolworth, Surrey, writes: "The instrument described by Dr. F. I. Callisen in *Nature* of February 1, p. 167, is being used in these laboratories. It is based on the description published by Dr. Luft-Oppau and has been further developed at our request by the Infra-Red Development Co., Ltd. A working model will be shown by Ascot Gas Water Heaters, Ltd., at the forthcoming Physical Society's Exhibition."

Announcements

Prof. W. J. de Haas, professor of experimental physics and meteorology in the University of Leyden, and Sir John Russell, formerly director of Rothamsted Experimental Station, Harpenden, Herts, have been elected foreign associates of the Paris Academy of Sciences.

The Committee of Privy Council for the Organisation and Development of Agricultural Research has appointed Mr. James Turner, president of the National Farmers' Union, to be a member of the Agricultural Research Council.

Mr. J. F. Foster, formerly registrar of the University of Melbourne and secretary of the Australian Vice-Chancellors' Committee, has been appointed secretary of the Universities Bureau of the British Empire, on the retirement of Mr. W. B. Brander from that office. Mr. Brander, who has been secretary since 1930, will continue for a while in an advisory capacity.

Mr. N. F. Astbury has been appointed director of research to the Guest, Keen and Nettlefolds group of companies. Mr. Astbury was director of the Research Laboratories of Joseph Sankey and Sons, Ltd., one of the member firms of this group. It is intended that these laboratories shall now become the headquarters of the research organisation of the combine.

The Research Council of Alberta is offering two fellowships, each of value 1,320 dollars for one year, tenable at the Council's laboratories, University of Alberta, open to graduates in chemistry and chemical engineering. Applications should be sent by air-mail to the secretary of the Council, University of Alberta, as soon as possible.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Phenolic Substances Concerned in Hardening the Insect Cuticle

THE hardening of the protein of insect cuticles is due to the tanning action of an agent produced by oxidation of a phenolic substance[1]. The hardening of the cockroach ootheca (*Blatta orientalis*) is analogous to this process, and we have recently demonstrated that the phenolic substance responsible in this case is 3 : 4-dihydroxybenzoic acid (I) (protocatechuic acid)[2]. Not only was this acid isolated in substantial quantity from the oothecæ, but also it was found that an aqueous solution of synthetic protocatechuic acid in presence of oxygen produced the characteristic darkening effect of the secretion of the right colleterial gland of the female cockroach upon the protein secretion of the left gland. This study of the cockroach ootheca represented the initial phase of a more extensive investigation of the hardening process in insects ; as a next step it was decided to attempt the isolation of phenolic substances from other species, to find out whether protocatechuic acid is a general hardening agent or whether the agent varies from species to species. The investigation is far from complete but, particularly in view of the general interest in the problem of the insect cuticle and the recent publications of Dennell[3] and Fraenkel and Rudall[4], it is felt that the results so far obtained are worthy of record at this stage. The species examined were *Calliphora erythrocephala*, *Lucilia cæsar* (puparia) and *Tenebrio molitor* (adults), and the experimental procedure and results can be summarized as follows.

Calliphora erythrocephala. A stock of mature larvæ which had ceased to feed were kept at room temperature ; they were examined daily, and any puparia (whether darkened or not) were picked out and stored in water containing a little cyanide and sulphur dioxide. When about 100 c.c. of puparia had been collected, they were crushed and extracted with acidulated aqueous alcohol (20 per cent) until the extract showed no ferric reaction. The aqueous alcoholic extract was concentrated *in vacuo* and then extracted continuously with peroxide-free ether. The ethereal solution so obtained was treated with diazomethane, evaporated, ester groups hydrolysed with methanolic potassium hydroxide, and the final product recrystallized from water and sublimed at 100°/10^{-1} mm. The acid isolated in this way had m.p. 178° and was identified as 3 : 4-dimethoxybenzoic acid (veratric acid) by direct comparison (m.p. and mixed m.p.) with an authentic specimen.

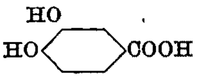
Tenebrio molitor. A stock culture was examined once a week and freshly emerged adults picked out and stored as above. When enough had been collected, the whole bodies were crushed and treated in the same way as the blowfly puparia. Two batches, collected from the same stock one after the other, were used ; the first contained about 2,000 and the second about 750 individuals.

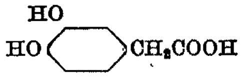
(1) The product from the first batch, after hydrolysis of ester groups, was unexpectedly soluble in water but separated from benzene/light petroleum as colourless crystals, m.p. 94–96°. After several recrystallizations from the same solvent mixture a homogeneous substance was obtained, m.p. 104–105° (20 mgm.) (found : C, 58·0 ; H, 5·9. $C_{11}H_{14}O_5$ requires C, 58·4 ; H, 6·2 per cent). From the analytical results it seemed likely that this acid was the hitherto undescribed α-hydroxy-β(3 : 4-dimethoxyphenyl)-propionic acid (3 : 4-dimethoxyphenyl-lactic acid). Accordingly, 3 : 4-dimethoxypyruvic acid[5] was subjected to catalytic hydrogenation; *dl*-α-hydroxy-β-(3 : 4-dimethoxyphenyl)-propionic acid so obtained (found : C, 58·3 ; H, 6·0. $C_{11}H_{14}O_5$ requires C, 58·4 ; H, 6·2 per cent) had m.p. 104°, undepressed in admixture with the acid isolated from *Tenebrio molitor*.

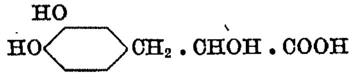
(2) The purified product (9·8 mgm.) from the second batch had m.p. 95–96°, undepressed in admixture with 3 : 4-dimethoxyphenylacetic acid (m.p. 95–96°)[6], but depressed by 3 : 4-dimethoxyphenyl-lactic acid. Further confirmation of its identity was provided by nitration ; the recrystallized nitro-compound formed needles, m.p. 209°, undepressed by 6-nitro-3 : 4-dimethoxyphenylacetic acid (m.p. 208°) synthesized by the method of Oliviero[7].

Lucilia cæsar. Extraction of *Lucilia* puparia (*c.* 500 c.c. collected as for *Calliphora*) with acidulated aqueous alcohol gave no material with a positive ferric reaction, and on working up the extract in the manner described above, the only crystalline product obtained was succinic acid (50 mgm.), identified by analysis, chemical properties, m.p. and mixed m.p. Extraction of the crushed larvæ with ether also failed to yield any phenolic material ; the unsaponifiable fraction of the ethereal extract contained, as crystalline constituents, a hydrocarbon (80 mgm.), m.p. 60–61° (found : C, 85·3 ; H, 14·9 per cent) and cholesterol (200 mgm.), identified by m.p., mixed m.p. and preparation of its acetate.

In the experiments above described, the phenolic acids present in the insect material were methylated with diazomethane in order to simplify working up, so that the products actually isolated were the corresponding methyl ethers. It is, however, clear that *Calliphora* puparia contain protocatechuic acid (I) and *Tenebrio* imagines 3 : 4-dihydroxyphenylacetic acid (II) and 3 : 4-dihydroxyphenyl-lactic acid (III). The presence of (II) in the elytra of the latter species has already been reported[8].


(I)


(II)


(III)

It would seem likely from the isolation of only 3 : 4-dimethoxyphenylacetic acid in one experiment with *Tenebrio* and of 3 : 4-dimethoxyphenyl-lactic acid in the other that, had larger amounts been available, both compounds would have been isolated in each case. Further work is required to settle this point and to establish whether any protocatechuic acid is present in the same insect. Fraenkel and Rudall[4] have shown that the substance responsible for the darkening of the blood after death is probably free tyrosine ; the first product of the action of polyphenol oxidase on tyrosine is probably dihydroxyphenylalanine, and it is interesting that the three phenolic acids so far detected by us represent a complete series of what would be the expected stable degradation products of the latter. It is, of course, clear that the preliminary experiments here reported do not provide any answer to the obvious question whether, in *Tenebrio*, (II) or (III) themselves take part in the hardening process, or whether they are intermediate products in the conversion of 3 : 4-dihydroxyphenylalanine to protocatechuic acid, which then acts as hardening agent.

On the mechanism of the hardening process itself, we have as yet made only a few preliminary studies, and our results will be communicated at a later stage. It would, however, seem likely that it is brought about by the condensation of the oxidized *o*-dihydroxy acid with protein chains to form stable cross-linked structures in which the nitrogen originally present in free amino-groups becomes directly attached to the aromatic nuclei. Such a reaction, which would give structures resistant to the attack of hydrolytic agents, has its analogy in the well-known condensations of quinones with amines, and in particular that of *p*-benzoquinone with glycine[9]. This hypothesis appears to be in harmony with all the known facts about the hardening process.

The failure to detect any phenolic acid in the *Lucilia* larvæ examined is rather striking and requires further study. It may, however, be bound up with the fact that darkening of the puparium in *Lucilia* is slower, and the final colour paler, than in *Calliphora* or *Sarcophaga*, so that the hardening agent may only be present in very small quantity at any one time. The function of the considerable amount of succinic acid isolated is obscure, but it is probably derived from the larval blood, since it has also been isolated from the blood of *Gastrophilus* larvæ[10].

M. G. M. Pryor
P. B. Russell
A. R. Todd

Zoological Laboratory,
Chemical Laboratory,
University of Cambridge.
Feb. 7.

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[1] Pryor, *Proc. Roy. Soc.*, B, **128**, 378, 393 (1940).
[2] Pryor, Russell and Todd, *Biochem. J.*, **40**, 627 (1946).
[3] Dennell, *Proc. Roy. Soc.*, B, **134**, 79 (1947).
[4] Fraenkel and Rudall, *Proc. Roy. Soc.*, B, **134**, 111 (1947).
[5] Kropp and Decker, *Ber.*, **42**, 1186 (1909).
[6] Kindler and Peschke, *Arch. Pharm.*, **271**, 431 (1933).
[7] Oliviero, *Gazz. chim.*, **65**, 143 (1935).
[8] Schmalfuss, Heider and Winkelmann, *Biochem. Z.*, **257**, 188 (1933).
[9] Fischer and Schrader, *Ber.*, **43**, 525 (1910).
[10] Private communication from Prof. D. Keilin.

Permeability of Insect Cuticle

I have chanced to make an observation, at present unexplained, which may throw light on the properties of insect cuticle.

The leg of the cockroach (*Periplaneta americana*) is somewhat transparent, and it is easy to observe the main trachea through the cuticle. If one puts a drop of water on the exterior of the leg, just over this trachea, minute droplets appear almost instantaneously inside the trachea. In all cases the droplets appear only in that length of the trachea which is covered by the outer drop. These droplets later coalesce, and if the water drop on the outside of the leg is allowed to evaporate they eventually disappear.

The droplets do not wet the intima of the cuticle, and are judged to consist mainly of water. They appear in both the amputated and living leg; if, however, the trachea is collapsed by mechanical pressure, etc., this phenomenon does not occur.

Similar droplets were also observed with certain other liquids (acetic acid, benzene, ether, etc.), but they disappeared more quickly than in the case of water. Droplets, however, did not appear with glycerine.

The droplets which appear in the trachea might be due to cooling and condensation of water following evaporation of the drop on the surface or to some osmotic effect, if one could postulate penetration of liquid through the cuticle. Direct chilling of the leg failed to produce this phenomenon, but if a drop of water is placed on a chilled leg, droplets still appear in the trachea. In the latter case temperature is gradually rising, so there is no question of further chilling. Moreover, arguing on theoretical grounds, the amount of water appearing in about 1 mm. length of trachea is much more than can be accounted for even assuming that the air inside the trachea is 100 per cent saturated and all the water vapour condenses. To test the second possibility, distilled water, a series of salt solutions (from 0·7 to 1·5 per cent) and cockroach blood were tried. In each case the droplets appeared. It is evident, therefore, that the droplets are not due to physical or chemical differences between external liquid and tissue fluids.

The cuticle of *Rhodnius* is sufficiently transparent, and it is easy to observe the main trachea through the cuticle in the abdominal segments on the dorsal side. Droplets can be produced in it by applying water externally.

Rajindar Pal

London School of Hygiene and Tropical Medicine,
Keppel Street, W.C.1.
Jan. 24.

Structures of Ethylene Oxide and *Cyclo*propane

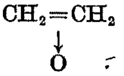
The recent communication of Walsh[1] includes several statements which are open to question. The suggestion that the reactions of ethylene oxide are at present considered to be due to instability caused by ring-strain is not acceptable without qualification and explanation. Nobody, one hopes, still retains any purely mechanical idea of strain such as one finds in the springs of models. Nowadays reactions are universally attributed to the functions of electrons and nuclei, and an interpretation of the special reactivity of such a series as acetylene, ethylene, *cyclo*propane and *cyclo*pentane can surely be found by the application of quantum mechanical principles to the usual formulæ. These represent nothing more than the mode of linking of the atoms in the molecule, combined with an indication of the degree of symmetry of the statistical distribution of electrons. Thus we may be confident that the ring-binding in *cyclo*propane has the symmetry of an equilateral triangle, that in ethylene oxide of an isosceles triangle, and that of propylene oxide of a scalene triangle. The usual formula for *cyclo*propane is therefore as satisfactory a symbol as can be devised.

The statement that trimethylene oxide is less stable than ethylene oxide is surely incorrect. Is this a case of the old confusion between stability (or reactivity) and ease of formation ?

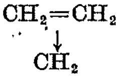
Again, the reactions of ethylene oxide are not to be compared with those of ethylene as stated by Walsh; they are, however, very similar to those of acetaldehyde. Under ordinary conditions of temperature and pressure, the olefines are anionoid in the first phases of reactions, whereas the aldehydes and ketones, and also the olefine oxides, are cationoid. That is, a reaction of ethylene is normally initiated by electron donation; a reaction of ethylene oxide by electron acceptance. The case of reaction with acids is exceptional in that a proton is probably first taken up by the non-bonded oxygen electrons, and in the resulting complex the oxygen–carbon link possesses enhanced cationoid character.

The claim that the conception of electron donation by bonding electrons is novel can be admitted only if it is limited to such new structures as those now proposed for ethylene oxide and *cyclo*propane. As a stage in reaction mechanism the idea can be traced back to Kekulé, whose theory of the formation of additive complexes and their redistribution can only be translated in modern terms by the use of reactive bonding electrons. If it were otherwise, saturated compounds could undergo no chemical transformations. Although it is true that a proton can often be regarded as a point of entry into the molecule, yet it is not difficult to find cases where the activity of a covalent link, carbon to carbon, should be assumed. For example, in 1916 I postulated[2] the conjugation of the unsaturation of *cyclo*propane and *cyclo*butane rings with an ethenoid group, and gave as an example of conjugated addition to such a system the formation of pinene hydrochloride, which occurs with intramolecular rearrangement.

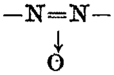
As a written symbolic expression, the formula (I) for ethylene oxide appears to be quite unsatisfactory. As pointed out by Walsh, (I) shows an analogy with the amine oxides, but the behaviour of ethylene oxide does not support the implications. There is, no doubt, a small dipole moment, but not that expected of a molecule containing $\rightarrow O^-$. The amine-oxides are easily reduced to amines; ethylene oxide is not reduced to ethylene but rather to ethanol, and that with no great ease. The very natural extension to the azoxy compounds would be incorrect. These substances cannot be formulated as (III); they have been proved to be (IV).


$\begin{array}{c}\mathrm{CH_2{=}CH_2}\\ \downarrow\\ \mathrm{O}\end{array}$

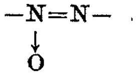
(I)


$\begin{array}{c}\mathrm{CH_2{=}CH_2}\\ \downarrow\\ \mathrm{CH_2}\end{array}$

(II)


$\begin{array}{c}\mathrm{-N{=}N-}\\ \downarrow\\ \mathrm{O}\end{array}$

(III)


$\begin{array}{c}\mathrm{-N{=}N-}\\ \downarrow\\ \mathrm{O}\end{array}$

(IV)

The formula (II) for *cyclo*propane is still less satisfactory. It does not express the symmetry of the molecule, and an attempt to achieve this by writing two other formulæ alongside would be nothing more than an admission of that degree of symmetry and in effect a reversion to the accepted structure.

What we need here is not new formulæ to set down on paper, but an explanation on quantum mechanical principles of the degree and quality of reactivity exhibited by assemblages of nuclei and electrons having the overall or average symmetry and spatial arrangement indicated by the usual structures and models. The overlapping of the orbitals would appear to supply this without the necessity for writing new constitutional formulæ.

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Feb. 10.

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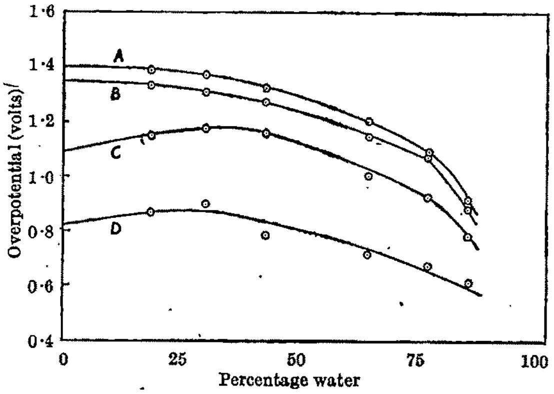
[1] Walsh, *Nature*, **159**, 165 (1947).

[2] Robinson, *J. Chem. Soc.*, **109**, 1042 (1916).

Effect of the Solvent on Oxygen Overpotential

RECENT work on the effect of the solvent on the hydrogen overpotential[1] has proved a fruitful source of evidence on the relative probability of the various suggested slow stages in the reactions at the cathode during the electrolytic evolution of hydrogen. No corresponding evidence seems to be recorded for the solvent effect on the oxygen overpotential, concerning which the following is a preliminary report. Few media are available for such experiments owing to anodic oxidation: aqueous acetic acid and aqueous dioxane were chosen for their suitable properties in this respect.



Curve *A*: 10^{-1} amp./sq. cm.; *B*, 5×10^{-2} amp./sq. cm.; *C*, 10^{-2} amp./sq. cm.; *D*, 10^{-3} amp./sq. cm.

Measurements have been carried out on smooth platinum anodes in a series of aqueous – non-aqueous mixtures containing these solvents, over a current density range of 10^{-3}–10^{-1} amp. sq. cm. The effects of both non-aqueous components are similar. The overpotential increases at first rapidly and then with decreasing slope upon increase of non-aqueous content (see graph). The Tafel equation ($\eta = a + b \log I$, where η is overpotential, I is current density, and a and b are constants) is approximately applicable in all systems; the values of b are all greater than in water. The increase in overpotential with time of polarization and the 'long-time' decay of overpotential after cessation of the polarizing current are not essentially affected by the solvent.

These results are not in accord with the slow discharge theory of Erdy-Gruz and Volmer[2], according to which possible solvent effects would be expected to depend primarily upon changes in the solvation energy of the OH^- ion; it seems very probable that this remains approximately constant in the systems examined[3]. From Eyring, Glasstone and Laidler's prototropic transfer theory[4], it seems logical to argue that presence of the non-aqueous component would serve to break up the continuous structure of solvent molecules bound to the anode and thus facilitate transfer of hydrogen atoms from the electrode to the solution layer. The overpotential would, therefore, be expected to be lower in aqueous – non-aqueous than in aqueous media, which is the reverse result to that found. Interpretation of the present experiments follows clearly from the assumption of the retardation of the heterogeneous combination of oxygen atoms caused by the presence of the non-aqueous component attached to the anode. It is assumed that both solvent components are adsorbed, but that, owing to steric factors, acetic acid and dioxane molecules exert a greater poisoning effect on the reaction velocity than water.

A fuller account of this work will be published elsewhere.

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London, S.W.7. Jan. 16.

[1] Hickling and Salt, *Trans. Faraday Soc.*, **37**, 224 (1941). Bockris, *Nature*, **158**, 584 (1946) and in the press. Bockris and Ignatowicz, in the press.

[2] *Z. phys. Chem.*, **165**, 53 (1932).

[3] Butler and Thompson, *Proc. Roy. Soc.*, A, **141**, 86 (1933).

[4] *J. Chem. Phys.*, **7**, 1053 (1939).

Spread Around the Initiating Point of the Detonation Wave in High Explosives

There is an old belief that the detonation wave in an explosive must travel a certain distance from the initiating point before attaining its final speed. In order to elucidate this problem, cylindrical charges of pressed T.N.T. have been fired with the detonator in different orientations and at various distances from the end surface of the charge. During experiments the flame was photographed on a film running with a constant speed of about 100 m./sec. Between the charge and the camera a screen with a vertical slit, 5 mm. wide, was fitted 1 m. from the charge. In all cases the axis of the charge was horizontal and pointed at the camera.

The charges with the dimensions 99·8 mm. × 99·8 mm. were initiated by electric detonators No. 8 from Imperial Chemical Industries Ltd. The priming charge consisted of a lead azide–lead styphnate mixture (0·22 gm.), and the base charge, 18 mm. long, of tetryl (0·688 gm.). The diameter of the detonator was 6·8 mm. and of the hole in the charge 7·2 mm. The centre of the free end surface of the detonator was placed at various distances, denoted *d*, from the photographed end surface of the charge. The axis of the detonator coincided in

Case 1 with the axis ; depth of the hole for detonator : 99·8-*d* mm.
Case 2 with a horizontal radius } depth of hole :
Case 3 with a vertical radius } 62 mm.

A typical photographic record is reproduced in Fig. 1. The time axis is a horizontal line assumed to lie at equal distances from the points of the two protruding horns, which mark the arrival of the detonation wave at the upper and lower intersections between a vertical line through the initiating point and the cylindrical surface of the charge. A relative displacement in the time direction of the horns indicates a vertical excentricity of the initiating point. Zero time is the point where a line through the points of the two horns intersects the time axis.

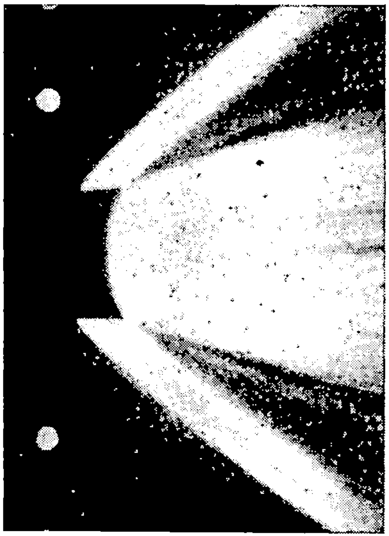

Fig. 1. Typical photographic record. Case 1, $d = 59{\cdot}5$ mm.

The curved front between the horns shows how the detonation wave successively reaches the end of the charge. A vertical tangent to this front marks on the time axis the travel time to the end surface after deducting the travel time to the cylindrical surface.

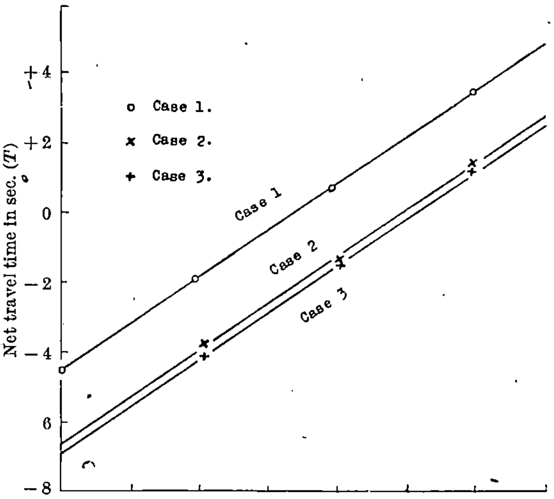

Fig. 2

The relation between this net travel time, *T*, and the distance, *d*, in the three cases is as shown in Fig. 2. In all cases the curves are straight lines with the same slope. Hence it may be concluded that the detonation is propagated with a uniform speed in all directions from the detonator.

For any distance *d* the difference between the travel times in Case 1 and Case 2 is about 2·1 μsec., which with due consideration of the detonation velocity of tetryl places the initiating point about 18 mm. from the free end of the detonator or almost exactly on the contact surface between the priming and the base charge. The small time difference (0·2 μsec.) between the lines of Case 2 and Case 3 may probably be explained by the fact that the depth of the hole for the detonator should have been 68 mm. instead of 62 mm. to get the initiating point exactly on the axis of the charge.

The slope of the lines corresponds to a wave-speed of 7,470 m./sec., which is 10 per cent higher than the generally accepted value 6,800 m./sec. for T.N.T. The discrepancy probably lies in the loss of speed when using built-up charges, as may be usual in routine tests. This question will be more thoroughly discussed elsewhere.

The camera was constructed and built by the Försvarets Forsknings Anstalt (FOA 2), who kindly placed the camera and some of their experts at our disposal.

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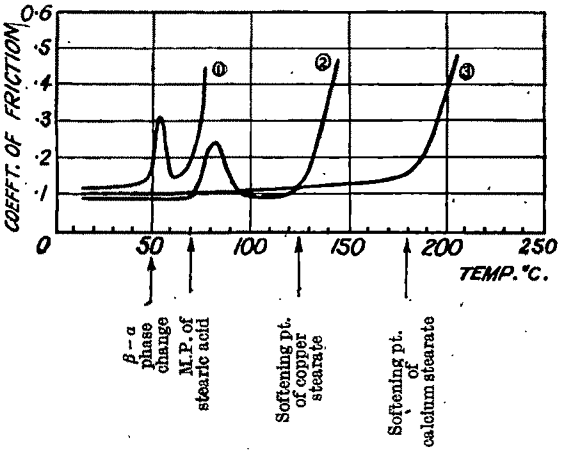
Jan. 27.

Lubricating Properties of Molecular Layers of Stearic Acid and Calcium Stearate on Metal Surfaces

FOLLOWING the work of Bowden, Gregory and Tabor[1], we have made friction-temperature measurements on mono- and multi-layers of calcium stearate and stearic acid on various metals. These authors stated that for each metal the transition from smooth to stick-slip sliding and a rise in the friction occurred at the melting or softening point of a surface film of metal soap produced by reaction with the fatty acid. It seemed, therefore, that in mixed films of soap and acid there should be fluctuations in the friction curve corresponding to the melting points of the substances present.

We deposited molecular layers of calcium stearate and stearic acid on copper, platinum and stainless steel by the Langmuir – Blodgett method[2] from a 10^{-4} molar solution of calcium carbonate. At *p*H 6 these layers contain 60 per cent soap and 40 per cent acid[3]. We used the Bowden – Leben friction apparatus to study the frictional behaviour.



(1) Platinum; (2) Copper; (3) Stainless steel

The temperatures at which changes in friction occurred corresponded closely to known physical changes of the layer substance in bulk (see graph and table).

Metal	No. of monolayers	Transition temperature (° C.)	Remarks
Platinum	1	No lubrication	
	3	,, ,,	β to α transformation at 54° C. M.P. stearic acid, 69° C.
	5	20–25 50–60	
	7	40–45 70	
	9	45–55 75–85	
Stainless steel	1	150–160	Softening point calcium stearate, 180°
	3	170	
	4	170–190	
Copper	1	No lubrication	
	3	70 125	M.P. stearic acid, 69°. Softening point copper stearate, 125°
	7	70 125	
	9	70 125	
	21	70 125	

With copper surfaces there are two fluctuations. The first, at the melting point of stearic acid, is not permanent and is thought to be due to the melting of the stearic acid, which, when liquid, is able to react with the surface, forming solid copper stearate. The friction then falls to its original low value and continues so until the softening point of copper stearate (125° C.), above which temperature a permanent increase in friction occurs.

On stainless steel no frictional changes occur at the melting points of stearic acid or ferric stearate (100–125° C.), but there is a transition at the softening point of calcium stearate (180° C.). With platinum, a fluctuation occurs below the melting point of stearic acid. Similar fluctuations are observed with palmitic and octacosanoic acids on platinum at 45° C. and 80° C. respectively. These temperatures are very closely similar to the temperatures at which β, α phase changes were observed in X-ray studies of monolayers of these acids on gold surfaces by Dupré la Tour[4]. It appears that the friction change is related to this phase transformation. There is also, as with copper, a sharp rise in friction at the melting points of the acids; but since no reaction can take place, no subsequent recovery occurs.

In general, each fluctuation corresponds to a softening or melting point of one of the constituents of the lubricating layer; but the frictional effects, and the number of layers required for lubrication, depend considerably on the nature of the underlying metal. Calcium stearate does not appear to lubricate copper and platinum, since with a mixed film, final breakdown of lubrication occurs at the same temperature as when pure stearic acid is spread on the surfaces[5]. Yet calcium stearate appears to lubricate stainless steel up to its melting point. This anomaly may be related to the fact that it requires only one molecular layer to lubricate steel compared with the three and five layers for copper and platinum respectively.

It is hoped that future work with an electron diffraction camera will give more information on these points.

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Dec. 24.

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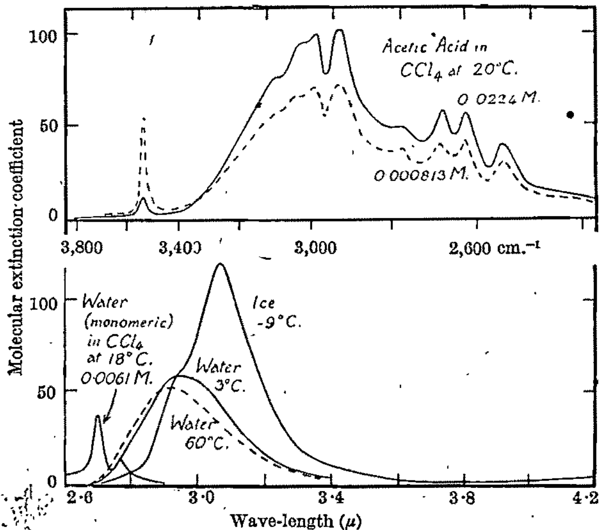
[1] Bowden, F. P., Gregory, J. N., and Tabor, D., *Nature*, **156**, 97 (1945).
[2] Blodgett, K., *J. Amer. Chem. Soc.*, **57**, 1007 (1935).
[3] Langmuir, I., and Schaefer, V. J., *J. Amer. Chem. Soc.*, **58**, 284 (1936).
[4] Dupré la Tour, *Ann. de Phys.*, **18**, 199 (1932).
[5] Ballantyne, C. S. I. R., (Tribophysics) Report No. A 137 (1945).

Hydrogen Bonding in Ice

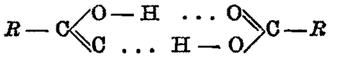
IN a recent communication in *Nature*[1], Prof. Max Born has discussed some features of the Raman spectrum of ice, more particularly in relation to the elastic constants. Since Prof. Born makes no use of the available infra-red measurements on ice[2] or of some earlier work on certain aspects of hydrogen bonding in ice, it seems worth while to recall some relevant data:

(1) Frequencies at 205–210 and 601 cm.$^{-1}$ occur in the Raman spectrum of ice[3,4] (calculated as 172 and 718 cm.$^{-1}$ by Prof. Born from the elastic constants of ice) and are also found in liquid water[3,4,5] less sharply defined at ~ 175 and ~ 500 cm.$^{-1}$. The lower frequency has for some years been identified as a hindered translation, and the higher as a hindered rotation or libration of an isolated water molecule in the surrounding water (or ice) structure. Bernal and Tamm[6] estimated these frequencies as 170 and 480 cm.$^{-1}$ in ice, and used them to calculate the specific heat of ice at the melting point.



(2) The broad Raman band of ice extending from 3,000 to 3,600 cm.$^{-1}$ is quite similar to the corresponding infra-red band (see accompanying graph), and both are generally regarded as being derived from the O—H vibrational frequencies in single molecules (3654 cm.$^{-1}$ in the Raman spectrum and 3,756 cm.$^{-1}$ in the infra-red spectrum), the parent frequency being reduced to a greater or lesser extent as a result of the influence of surrounding molecules in the liquid and solid states. Prof. Born appears to dislike this explanation; but the effect is quite characteristic of hydroxylic bodies generally (alcohols, phenols, carboxylic acids), and in each case the sharp O—H band observed for the monomeric substance becomes blurred, with a somewhat lower average frequency and greatly increased intensity of absorption as soon as association takes place. There is good evidence from infra-red measurements that the change of frequency from O—H (monomer) to O—H (polymer) is a measure of the strength of the hydrogen bond[7]; for example, when ice melts there is a shift of the O—H band to higher frequencies (see graph) corresponding to a reduction in the degree of association, and this effect continues steadily as the temperature of the water is increased.

A case of hydrogen bonding of considerable interest is afforded by acetic acid dissolved in carbon tetrachloride (see graph). The monomeric O—H band is clearly observed at 2·83 μ (3,534 cm.$^{-1}$), and rapidly diminishes with increasing concentration while the broad association band increases. The nature of the association between carboxylic acid molecules is established from electron diffraction measurements on formic acid[8]; the molecules are supposed to be associated in the form of a ring dimer



$$R-C\begin{matrix}\diagup O-H\ \ldots\ O\diagdown\\ \diagdown O\ \ldots\ H-O\diagup\end{matrix}C-R$$

with an O—H . . . O separation of 2·67 A. At low concentrations the rings split up into single molecules, and an equilibrium is set up.

$$R.\text{COOH}+R.\text{COOH} \rightleftarrows 2(R.\text{COOH}).$$

The difference between the association in ice and in acetic acid dissolved in carbon tetrachloride, as shown in the graph, is very marked, and clearly develops at very low concentrations in the latter case, due presumably to the stabilizing effect of the compact ring structure as compared with the less well-defined water complexes. The maximum possible effect on the O—H frequency of acetic acid as a result of hydrogen bonding would be obtained when the hydrogen atom occupies a mid-way position between two competing oxygen atoms, and in these circumstances the O—H distance would be approximately 1·335 A. instead of about 1 A. in the single acid molecules. A rough calculation shows that the frequency to be expected in this extreme case is ~ 2,330 cm.$^{-1}$ (~ 4·3 μ), and the curve shown does indicate a limiting value approaching this. No such extreme value is, however, found in ice, and the comparatively small frequency shift observed in this substance must mean that the average O—H distance is not greatly changed from the normal value in single molecules. A rough calculation indicates an average extension of the O—H bond in ice of perhaps 5 per cent.

(3) Prof. Born states that there is no line in the Raman spectrum of ice in the region between 800 and 2,900 cm.$^{-1}$; this is incorrect, as there is a Raman line at 2,225 cm.$^{-1}$ in ice at 0° C.[3]. The corresponding infra-red frequency is 2,222 cm.$^{-1}$ in ice at 0° C., while the values for water at 0° C. are ~ 2,170 and 2,149 cm.$^{-1}$, respectively. This frequency has been interpreted as a combination of the deformation frequency ν'_s (~ 1,650 in ice and water) and the frequency of hindered rotation ν_R previously mentioned[2,9]. Thus we have

$$\nu'_s + \nu_R = 1{,}644+601=2{,}245 \text{ for ice } (2{,}222 \text{ observed})$$

and

$$1{,}646+500 \doteq 2{,}146 \text{ for water } (2{,}128 \text{ observed at } 21^\circ \text{ C.}).$$

The ~ 2,150 cm.$^{-1}$ frequency in water (4·7 μ band) has a particularly strong temperature dependence, and this is attributed to the naturally large variation of ν_R with temperature.

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Sir Howard Grubb Parsons and Co.,
Optical Works,
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Jan. 11.

[1] Born, *Nature*, **158**, 830 (1946).

[2] Fox and Martin, *Proc. Roy. Soc.*, A, **174**, 234 (1940).

[3] Hibben, *J. Chem. Phys.*, **5**, 166 (1937).

[4] Cross, Burnham and Leighton, *J. Amer. Chem. Soc.*, **59**, 1134 (1937).

[5] Magat, *J. Phys. Radium*, **5**, 347 (1934).

[6] Bernal and Tamm, *Nature*, **135**, 229 (1935).

[7] Fox and Martin, *Trans. Faraday Soc.*, **36**, 897 (1940).

[8] Pauling and Brockway, *Proc. Nat. Acad. Sci.*, **20**, 336 (1934).

[9] Ellis, *Phys. Rev.*, **38**, 693 (1931).

Low-Pressure Electrical Discharges

SOME experiments awaiting publication show how remarkably easy it is to start high-frequency electrodeless discharges at pressures of the order of 1/100 or even 1/1,000 mm. of mercury in a uniform electric field. For a bulb of given size, the wave-lengths must be less than a certain value which is directly proportional to the diameter of the bulb. A rough working rule is that the maximum permissible wavelength (measured in metres) is four times the diameter of the bulb (measured in centimetres). If the pressure inside the bulb is increased from the above small value, this 'cut off' wave-length is also increased, and at a still higher pressure the 'cut off' disappears. At wave-lengths beyond the 'cut off' enormous voltages are required to get a discharge—if one can be got at all. The discharge starts most easily for wave-lengths from about one half to three quarters of the 'cut off' wave-length.

Provided the bulb is in a fairly uniform field (which is produced well enough by using circular parallel plates of diameter about one and a half times the bulb, with the bulb in between and close to both) a very moderate voltage will start the discharge. A peak value of the order of 100 volts will suffice whatever the size of the bulb if the above appropriate wave-lengths are used. When the discharge has once started, a peak value of considerably less will maintain it. All the power required can be got from a high-frequency generator running on 40–50 watts.

The most interesting fact is that the starting potential at these low pressures is independent of the nature of the gas, however carefully it is purified. Helium, hydrogen, air and mercury were used in bulbs varying from 3 cm. to 20 cm. in diameter, or flat-ended tubes a few centimetres long.

It follows that, at any rate initially, the large increase in the number of the few electrons present, necessary to start a discharge, when the high frequency is applied, cannot be due to gas ionization alone. The only other possibility of increase is secondary emission from the glass, and taking this as the main factor a simple theory is in good agreement with the main experimental results and with secondary-emission data given by Bruining[1].

Additional confirmation was the fact that if the glass surface is varied, the starting potentials are altered, in some cases very considerably. The theory was based on five simple considerations: (1) The velocity of electron impact on the glass has to be sufficient for each primary on the average to liberate more than one secondary. (2) The secondaries have a small emission velocity. (3) The phase has to be such that the secondaries cross the tube and are not pulled back by the alternating field to the glass from which they came. (4) That for constant increase in numbers this process must be repeated exactly every half-cycle. (5) That the electron velocities necessary to satisfy the above conditions are quite sufficient to ionize readily any gas by a collision.

The work was assisted by a grant from the Department of Scientific and Industrial Research.

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A. VON ENGEL
Electrical and Clarendon Laboratory,
University, Oxford. Feb. 1.

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[1] Bruining, H., "Sekundärelektronen-Emission fester Körper" (Berlin: Springer-Verlag, 1942).

Micro-Wave Solar Noise Observations During the Partial Eclipse of November 23, 1946

DURING the partial eclipse of the sun on November 23, 1946, a record of the reduction of radio-frequency energy emitted from the sun in the 2800-megacycle band was obtained at Ottawa, Canada. At this station, the eclipse commenced at 10.45.5 E.S.T., reached a maximum at 12.18 and ended at 13.51. At noon the sun was at an altitude of 23°, with its axis of rotation 19° east of north. The clear sky permitted the taking of photographs of the sun at the Dominion Observatory. Data from these are shown in Fig. 1.

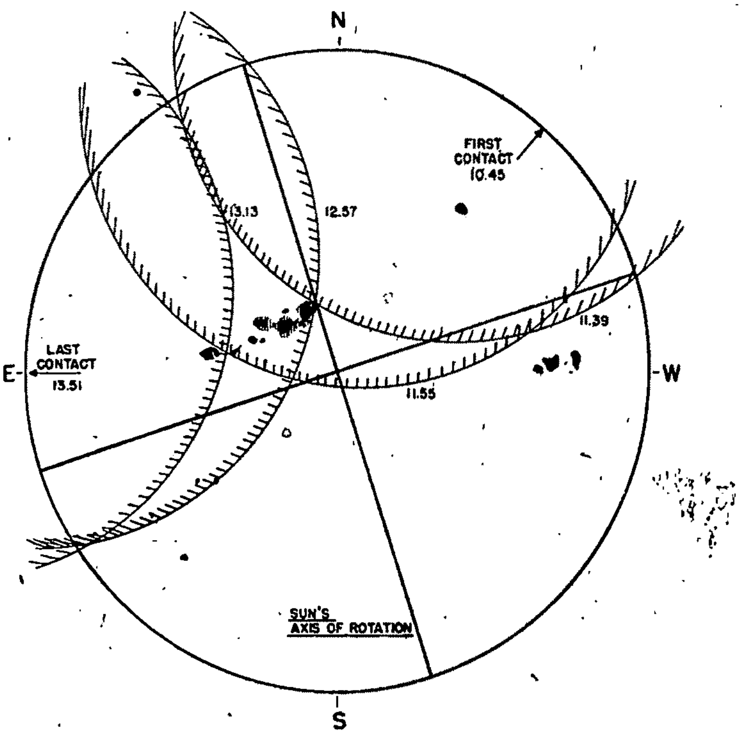

Fig. 1. LUNAR SHADOW POSITIONS OUTLINING ACTIVE REGION. DATA FROM DOMINION OBSERVATORY PHOTOGRAPHS

The sun's radiation, contained in two 5-megacycle bands centred about 2800 megacycles, was continuously received by a parabolic reflector, astronomically mounted and driven to follow the sun. Once every hour the drive was corrected manually to compensate for errors in following. The dipole antenna placed at the focus of the mirror was oriented so that its axis was parallel to the sun's axis of rotation; thus the plane of polarization of the received energy was fixed with respect to the sun's axis. The beam-width, 6° to the half-power points, allowed the total radiation from the sun and surrounding space to be received. The receiver, constructed after the manner of Dicke[1], measured over a short period of time the relative changes of energy to within 1 per cent. For a longer period of time, the sensitivity showed a gradual change. Calibration with a thermal load before and after the eclipse showed that the receiver sensitivity had decreased by 12 per cent. In allowing for this drift, it was assumed that the change was linear with time. At times shown by breaks in the record (Fig. 2), the antenna was moved from the sun in order to obtain the background as a reference point. The receiver output was used to drive a recording milliammeter.

Curve *A*, Fig. 2, shows the percentage antenna temperature smoothed to eliminate receiver noise and corrected for changes in sensitivity; curve *B* shows the percentage eclipsed area of the sun's photosphere. The observational results are: (1) a 15 per cent rise in the sun's temperature after the end of the eclipse; (2) small temperature fluctuations of about 7 per cent before the eclipse; (3) (*a*) a definite drop 3·0 min. before the moon made its first visible con-

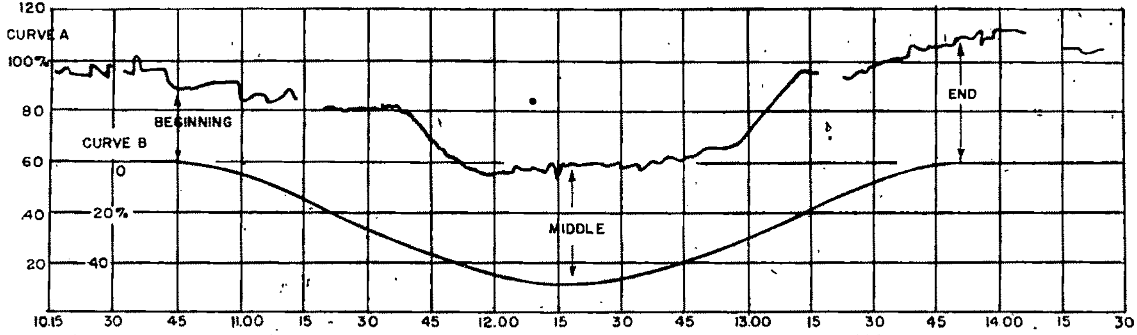

Fig. 2. CURVE *A*, VARIATION OF SOLAR NOISE DURING ECLIPSE, NOVEMBER 23, 1946. CURVE *B*, ECLIPSED AREA OF SUN

tact. At this instant the moon's edge was 1·05 times the sun's radius from the centre of the sun. Details of change are shown in the table below; (3) a gradual return during the last part of the eclipse; (4) a decrease occurring at 11.39 and an increase at 12.57 E.S.T.

Minutes before contact	Percentage reduction
3	0
2	4·8
1	6·5
0	8·0
−1	9·5
−2	9·5

Since the discovery of solar noise by Southworth[2] and Reber[3], and the subsequent discovery by Pawsey, Payne-Scott and McCready[4] that the sunspot areas are particularly active noise generators in a lower-frequency region (about 200 megacycles), records obtained during a solar eclipse will give information regarding the noise distribution over the sun's surface. In the microwave region (24,000 megacycles) reference should be made to the results of Dicke and Beringer[5] obtained during the eclipse of 1945. Fortunately, during the present eclipse, a large group of spots was obscured by the moon at 11.39 and uncovered at 12.57. It is believed that this is the interpretation of the sudden change of energy (25 per cent) during the middle of the eclipse marked by the fall and rise at the times indicated. The noise-generating region, totalling 2·2 per cent of the sun's projected surface and containing the sunspot group, is outlined by the four lunar shadows shown in Fig. 1. With the present data, this area has an equivalent temperature of $1\cdot5 \times 10^{6}$° K. in excess of the average surface temperature of $5\cdot6 \times 10^{4}$° K. This average is obtained for the eclipsed portion of the sun disregarding the spot area.

Before the first contact, the substantial reduction in energy might indicate that the source is in the space surrounding the sun, either from the corona or from a prominence. Calculation of the equivalent temperature of the crescent-shaped area swept out by the moon during the three minutes before contact gives 3×10^{6}° K. From the rate at which the temperature fell, most of the energy is produced in a region just off the visible limb. Photographic evidence for such a local disturbance has not yet been obtained.

No obvious correlation has been obtained between the disappearance of the isolated spot in the north-east quadrant of the sun and any sudden drops in radiation. The large group south of the equator was not eclipsed, although an active region surrounding this spot could have been partially eclipsed for a short time.

I much appreciate the assistance given by members of the Dominion Observatory.

A. E. COVINGTON

National Research Council,
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Dec. 16.

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[1] Dicke, R. H., *Rev. Sci. Instr.*, **17**, 268 (1946).

[2] Southworth, G. C., *J. Frank. Inst.*, **239**, 285 (1945).

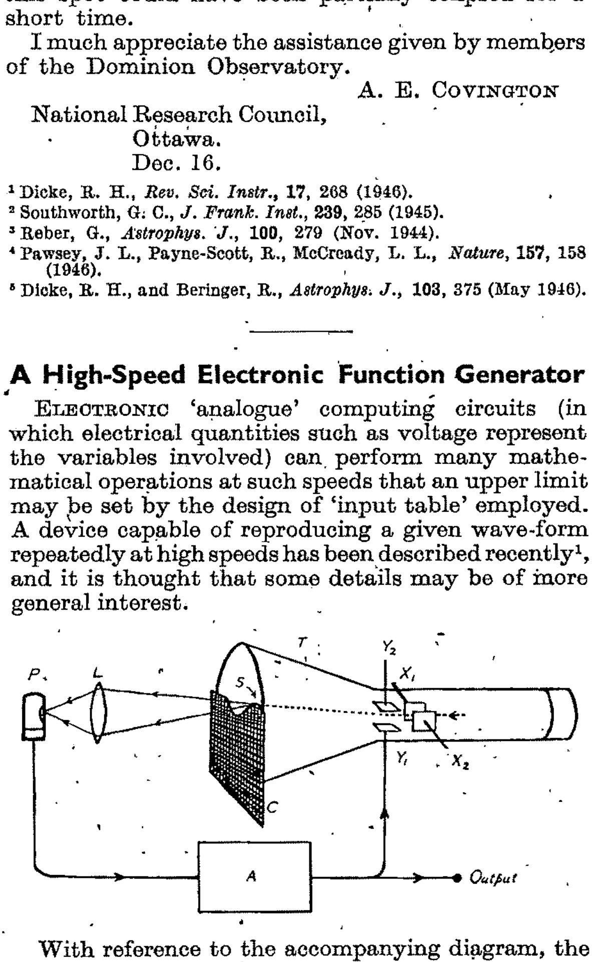
[3] Reber, G., *Astrophys. J.*, **100**, 279 (Nov. 1944).

[4] Pawsey, J. L., Payne-Scott, R., McCready, L. L., *Nature*, **157**, 158 (1946).

[5] Dicke, R. H., and Beringer, R., *Astrophys. J.*, **103**, 375 (May 1946).

A High-Speed Electronic Function Generator

ELECTRONIC 'analogue' computing circuits (in which electrical quantities such as voltage represent the variables involved) can perform many mathematical operations at such speeds that an upper limit may be set by the design of 'input table' employed. A device capable of reproducing a given wave-form repeatedly at high speeds has been described recently[1], and it is thought that some details may be of more general interest.



With reference to the accompanying diagram, the edge of an opaque card *C* is cut to the required shape, and the card placed over the face of a cathode-ray tube *T*. A lens *L* focuses light from the spot *S* on a photocell *P*, the output of which is coupled through an amplifier *A* to one of the deflector plates of the tube Y_1, in such a sense that an *increase* in the intensity of light would deflect *S towards* the region of the screen obscured by *C*.

Given suitable optical shielding and sufficient overall gain, *S* will be constrained to adopt a position partially obscured by *C*, and will follow the curved edge of *C* if subjected to *X*-deflexion. (It must be noted, however, that the persistence of screen afterglow corresponds to an integrating term in the feed-back loop, setting an upper limit both to the frequency response and to the gain of A in accordance with Nyquist's criterion of stability[2].

If $y = F(x)$ be the equation of the curved edge relative to the *deflexion axis*, this will also (very nearly) be the equation of S, so that if S be deflected linearly with time in the X-direction, the output wave-form will be an electrical replica of the curve. More precisely, if the co-ordinates of S are (x, y), and voltages on the Y_1, Y_2, X_1, X_2 plates are p, q, r and s respectively, we have

$$p - q = \frac{y}{k_1}; \quad r - s = \frac{x}{k_2},$$

where k_1 and k_2 are normally constant, being inversely proportional to the accelerating voltage V of the tube. Hence the output voltage p will obey the law $p = q + \frac{1}{k_1} . F[k_2(r - s)]$, where q, r and s (and to a limited extent, k_1 or k_2) are independent variables, and F can include rotation and displacement of the axes to which the curve was originally drawn.

Since one can also set either r or s equal to p or q, the device is capable of generating quite a variety of functions, at a speed limited only by the frequency response of the system, conditioned mainly by the type of screen employed. Special screens are available with afterglow times of the order of microseconds, so that a 'scan time' of the order of milliseconds is feasible, and virtually continuous cathode-ray tube presentation of the output of a differential analyser using such a device should be possible, with obvious advantages when dealing with, for example, equations having variable coefficients. Other obvious possibilities are suggested by the ease with which functions such as log x, e^x, etc., can be generated, and are at present being investigated.

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Jan. 27.

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[1] Brit. Prov. Pat. Spec. No. 36849, 1946.

[2] Nyquist, *Bell System Tech. J.* (January 1932).

Latent Energy and After-glow in Flame Gases

The energy present in long-lived latent form in flame gases resides, I think, in very stable abnormal triatomic molecules formed during combustion. The amount of latent energy in flame gases resulting from combustion at constant pressure is rarely less than about 15 per cent of the heat of combustion, and, if this view is correct, the numbers of abnormal molecules must be large.

It has been suggested, by way of criticism of this, that the luminosity (after-glow) of flame gases indicates that there can only be an exceedingly small concentration of excited molecules. But this suggestion fails to account for the remarkable persistence of the after-glow in all cases where cooling of the flame gases does not take place rapidly. The numerous flame photographs taken by various observers show this clearly[1], and to the eye, of course, it persists for much longer than the photographs indicate. Indeed, after the explosion of a perfectly mixed inflammable mixture in a large vessel, it has been seen to exist for 0·4 sec., and there seems to be little doubt that were it possible to isolate hot flame gases away from surface, and under conditions such that cooling did not take place, it would remain for a time which could be measured in minutes. Furthermore, flame gases after being cooled to darkness by adiabatic expansion can be made luminous again by adiabatic compression[2].

It does not seem to be possible to account for the persistence of the after-glow unless it is assumed that large numbers of abnormal molecules of great stability are formed during combustion (just as was inferred from latent energy measurements), and that the *rate* at which these molecules reach the ground-state is exceedingly small. Individual molecules would not appear to possess sufficient energy for the emission of light quanta, and it seems probable that this can only happen during the infrequent collisions of sufficiently energized pairs of them. The rate at which such collisions take place, and therefore the intensity of the after-glow, depends both upon the concentration of the abnormal molecules, which varies with the amount of latent energy, and upon the flame gas temperature. This is in accord with experiment[3].

The hypothesis outlined above may also serve to explain the continuous background observed in carbon-monoxide and hydrogen flame gas spectra.

There is, I think, now no doubt that even in ordinary open flame gases some 25 per cent of the heat of combustion is in the form of latent energy and the abnormal dissociation[4] which results from it. This energy is released when the flame gases impinge upon surface.

It is hoped to publish shortly the evidence for this.

W. T. David

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Jan. 20.

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[1] See, for example, Ellis and Wheeler, *J. Chem. Soc.*, plate v, p. 318 (Feb. 1927).

[2] *Phil. Mag.*, 9, 399 (1930).

[3] *Nature*, 155, 273 (1945).

[4] *Proc. Inst. Mech. Eng.*, 151, 236 (1944).

"Turbulent Flow in Alluvium"

Sir Claude Inglis, in his letter published in *Nature* of October 19, p. 552, remarks that my formulæ for alluvial flow are based on two fundamental relationships. It would be more correct to state that two independent fundamental equations are necessary to a complete solution, and that each of these equations consists of an empirical correlation of dimensionless numbers or 'arguments', derived from the essential variables. Dr. White has produced a partial solution, which effectively ignores the Reynolds number. The following solution appears to be complete.

There appear to be seven essential variables involved, namely :

P	wetted perimeter	μ	viscosity of water
R	hydraulic mean depth	g	acceleration due to gravity
V	mean velocity		
ρ	density of water	$i = gRS$	energy gradient

These are the traditional variables. It will be observed that the density, grade and quantity of the charge do not enter within this framework: They are implicit in the values assumed by V, R and S for a given value of Q the discharge. These seven variables demand the following four dimensionless arguments:

$$V^2/gRS\ ;\quad V^2/gR\ ;\quad RV/\mu\ ;\quad P/R,$$

in which the slope S has been inserted by substitution.

Of these four arguments any one may be expressed as an empirical function of any two of the remaining three. Two equations thus afford a complete solution, and they may be written:

$$P/R \;=\; \tfrac{1}{2}\,(V^2/gR)^{1/3}\,(RV/\mu)^{1/3} \qquad (A)$$
$$V^2/gRS = \tfrac{1}{4}\,(V^2/gR)^{-2/3}\,(RV/\mu)^{1/3}. \qquad (B)$$

These two equations reduce to

$$P = 2{\cdot}78Q^{1/2},$$

and

$$V = 15{\cdot}8R^{2/3}\,S^{1/3},$$

when the temperature of the water is 30° C.

The coefficients $\tfrac{1}{2}$ and $\tfrac{1}{4}$ respectively in the two basic equations appear to be pure numbers under ideal conditions.

On elimination of the Reynolds number from the basic equations, my equation published in *Nature* of August 3, p. 166, immediately results, namely:

$$\begin{aligned} V^2/gRS &= \tfrac{1}{2}\,(gR/V^2)\,.\,P/R \\ &= \tfrac{1}{2}\,gP/V^2. \end{aligned} \qquad (C)$$

The manner in which the three arguments enter should be noted. The new Froude number V^2/gP is none other than the usual Froude number V^2/gR divided by the shape number P/R. Similarly the 'White' number $ag^{2/5}/Q^{4/5}$ raised to the fifth power is none other than $P/R\ .\ (gR/V^2)^2$.

It would appear desirable, when making an attack on any dimensional problem, to express the new dimensionless numbers involved, if possible, in terms of more familiar dimensionless arguments. When this is done, the precise nature of the assumptions made is more readily appreciated.

The difficulties experienced in the past in the dimensional treatment of alluvial channels in loose material have arisen from the fact that the full implications of an ideal self-generating channel have not been understood. Old methods have been employed to solve a new problem. The reappearance of the old familiar dimensionless arguments, or numbers, is, however, reassuring.

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Dec. 9.

Submarine Tubes for Levelling

THE ocean surface deviates from the geoid, that is, from a level surface, by an amount probably exceeding one metre even if short-period disturbances such as waves and tides are eliminated. It therefore cannot serve as a datum for precise levelling. Coasts separated by water can, however, be joined by hydrostatic levelling, recently described by Nørlund. In 1938 he 'bridged' the Store Belt[1] in Denmark with a water-filled submarine tube of length 18 km. and inside diameter 1 cm.; the greatest depth was 60 m. Observations of atmospheric pressure at each end and of temperature distribution along the tube served to determine the difference in level between the water surfaces inside each end. In 1939 he joined the spirit-level networks of Denmark and Sweden by means of a 4·2 km. submarine tube beneath Oresund[2].

Nørlund's new method can furnish information needed in physical oceanography. The relations between current and slope of the ocean surface, except the part due to difference in atmospheric pressure, are the same as the more widely known relations between wind and slope of an isobaric surface in the atmosphere. Previous knowledge about the level or geopotential of the ocean surface has depended entirely upon the spirit-level method and the oceanographic method. The latter method gives the difference in geopotential between point 1 and point 2 in the form

$$\varphi_2 - \varphi_1 = -\int_{p_1}^{p_2} \alpha\, dp\,;$$

the integral of specific volume α with respect to pressure p from point 1 to point 2 must be carried out along an instantaneous path consisting only of (*a*) vertical lines, and (*b*) lines along which the horizontal component of the pressure gradient vanishes. The distribution of specific volume is obtained by ordinary oceanographic methods. The path is so chosen that non-vertical parts are at great depths, where condition (*b*) can be expected to be approximately fulfilled.

Hydrostatic levelling is similar to oceanographic levelling, but has the advantage that the water in the tube comes to rest or oscillates about a position of equilibrium, so that condition (*b*) is necessarily fulfilled. The difference in geopotential between the two ends can, therefore, be computed from the equation above. Since the tube is filled with a liquid of known pressure-volume-temperature relationship, the necessary data are obtained by measuring the pressures p_1 and p_2 inside the ends, and the distributions of temperature and of approximate depth along the tube.

Hydrostatic levelling across the Straits of Florida would provide basic information concerning the Florida Current, the source of the Gulf Stream. The distance from Miami, Fla., to Cat Cay, B.W.I., is 82 km.; the greatest intervening depth is about 900 m.

Not only can any two coastal points be joined by hydrostatic levelling, but also any coastal point can be joined with any point on the ocean surface if a tube holding a known liquid starts from the coastal point and has an open end on the bottom near the ocean point. In addition to the pressure p_1 at the coastal point and the atmospheric pressure p_2 at the ocean point, and to the temperature distribution along the tube, the distribution of specific volume below the ocean point must be measured. The path of integration lies from p_1 through the length of tube and vertically upward through the ocean water to p_2.

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Jan. 22.

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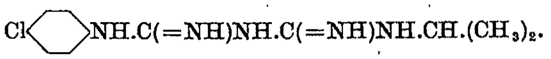
[1] Nørlund, N. E., Geodaetisk Instituts Skrifter, København, 3. raekke, 6, 122 (1945).

[2] Nørlund, N. E., Geodaetisk Instituts Skrifter, København, 3. raekke, 7, 84 (1946).

Activation of Paludrine *in vitro*

PALUDRINE has recently been introduced into clinical medicine as a drug which is highly active against most species of malaria parasite ; its formula is



Tonkin[1], in this laboratory, investigated its effect on the exoerythrocytic forms of *P. gallinaceum* grown in tissue culture, and found that it had no action upon the parasites in the highest concentrations (2–5 mgm. per litre) tolerated by the macrophages. Since this concentration is many times greater than that which is believed to be present in the plasma in human therapy (probably about 0·3 mgm. per litre) its inactivity was surprising ; and the action of paludrine *in vitro* has been investigated further using *P. cynomolgi* of monkeys, and the exoerythrocytic forms of *P. gallinaceum* grown in tissue culture, as test organisms. *P. cynomolgi* was cultured *in vitro* at 37° C. by a modification of Bass and John's technique and, 41 hours later, smears were made and stained with Giemsa. The parasites found were classified according to the number of pieces of chromatin present, and the resulting differential counts are shown in the accompanying table. The figures indicate the percentage of parasites containing 1, 2–3, 4–5 pieces of chromatin, etc., respectively.

	1	2–3	4–5	Greater than 5	Degenerate	Gametocytes
Original blood	90	10	0	0	0	0
Control *A*	0	6	31	49	10	4
Paludrine added to serum *A*						
2 mgm. per litre	7	27	23	26	9	8
1 mgm. per litre	7	25	26	31	4	7
Paludrine serum (*B*)	54	23	5	5	10	3
,, ,, 1/4	28	46	21	2	0	3
,, ,, 1/16	24	42	16	2	8	8
,, ,, 1/64	18	42	24	6	2	8

Monkey *A* was the donor which provided the parasites, and the serum for the controls and for dilution of serum *B*, etc. Serum *B* came from a monkey (weighing 3·4 kgm.) which had received two intramuscular injections, each of 50 mgm. paludrine acetate, 21 and 5 hours previously. Previous experiments had shown that the serum of this monkey had no injurious effects on malaria parasites obtained from monkey *A*.

The table shows that the parasites were originally present as forms with only one piece of chromatin ; most of them were small rings. After 41 hours a large proportion in the control tube *A* had developed so that 49 per cent now possessed more than five pieces of chromatin (at complete schizogony there are sixteen pieces). Very similar development had occurred in the tubes to which paludrine had been added in relatively high concentration. In the tubes containing serum *B* from the monkey treated with paludrine, development of the parasite was inhibited to a considerable extent, so that 6 per cent or less of the parasites had reached the stage of more than five pieces of chromatin. (Other degenerative changes, which cannot easily be expressed in quantitative terms, were also present in the parasites of these tubes.) This inhibition was marked even in the tube which contained only 1 part of serum *B* diluted with 63 parts of *A*.

Similar results have been obtained in tissue cultures of the exoerythrocytic forms of *P. gallinaceum*. Serum from a fowl treated with paludrine possesses an antiplasmodial action which is absent when paludrine is added directly to the cultures. These findings are in agreement with those of Black[2], who reported that serum from a patient treated with paludrine arrested the development of trophozoites of *P. falciparum* when cultured *in vitro* ; he did not examine the effect of adding paludrine directly to his cultures. It is concluded that probably paludrine does not itself possess antimalarial action, but that it is converted by the body into something which is active.

F. HAWKING

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London, N.W.3.
Feb. 3.

[1] Tonkin, I. M., *Brit. J. Pharm.*, 1, 163 (1946).

[2] Black, R. H., *Trans. Roy. Soc. Trop. Med. and Hyg.*, 40, 163 (1946).

An Œstrogenic Substance in Pollen-grains of Date Palm Tree *Phœnix dactylifera* L., Palmæ

THE term œstrogen or œstrin is now used to designate the whole group of œstrus-inducing substances irrespective of its constitution or origin.

The natural œstrogenic hormones are of wide occurrence, and although œstrogenic substances have been found in mineral sources yet none of naturally occurring œstrogenic hormones has been detected among them. A surprising discovery was that œstrin occurs in the vegetable kingdom. Butenandt and Jacobi[1] succeeded in isolating pure œstrone from a palm-kernel extract, and Skarżyński[2] obtained from female willow flowers a crystallizate of pure œstriol, the hormone hydrate. The substances isolated from the plants produced a typical œstrus response in ovariectomized rats.

We have found an œstrogenic substance in pollen-grains of the palm plant. The active part is found in the non-saponified fraction of the oil extracted from the dry pollens. A water-soluble form of this active part was made according to Marrian's method and tested biologically. A batch of eleven ovariectomized rats weighing 140–160 gm. were divided into three groups.

Group 1. Three rats received no supplement and used as negative controls.

Group 2. Three rats injected with pure œstradiol dipropionate and used as positive controls.

Group 3. Five rats injected with the water-soluble form obtained from the palm pollen-grains in four doses over a period of twenty-four hours.

All groups were kept under observation and showed no cycles during a preparatory period of two weeks, after which both groups 2 and 3, which were injected with the active material at the same time, showed simultaneously identical complete cornification of the vaginal smear twenty-four hours after the last injection.

This proved the occurrence of a biologically active œstrogenic substance in the pollen-grains of the palm plant.

A spectroscopic examination of this fraction dissolved in absolute alcohol showed an absorption band in the ultra-violet region near 282 mμ, as compared with the 280 mμ of œstrone.

On addition of concentrated sulphuric acid to a chloroformic solution of this fraction, an orange coloration is observed which is changed to a red solution on adding a few drops of water and heating in a boiling water bath (Kober's test for œstrone[3]). The active part also gives a red coloration with Marrian's phenol-sulphonic acid reagent[4] specific for œstrone.

This problem was suggested by H. E. Dr. S. Azmy Pasha, professor of medicine. Further work is in progress to identify and to isolate this biologically active œstrogenic material.

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M. HASSAN ABOU EL WAFA

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Fouad I University,
Cairo. Dec. 28.

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[1] Butenandt and Jacobi, *Z. physiol. Chem.*, **218**, 104 (1933).

[2] Skarzynski, Bull. Int. Acad. Pol., Class, Sec. Sci. Math. Nat., B 11, 347 (*Chem. Abst.*, **28**, 4755; 1934).

[3] Kober, S., *Biochem. Z.*, **239**, 209 (1931).

[4] Cohen and Marrian, *Biochem. J.*, **28**, 1603 (1934).

[5] Callow, R., *Biochem. J.*, **30**, 906 (1936).

Mauthner's Cells in the Larvæ of Anuran Amphibia

THE cells of Mauthner occur in the medulla oblongata of many teleost fishes, Dipnoi and urodele Amphibia, where they have been widely studied. On the other hand, their occurrence in the larvæ of anuran Amphibia has been disputed for many years, and to judge from the literature most attempts to find them have failed. Szepsenwol[1] claims to have found them in the larvæ of *Rana fusca* and *Bombinator pachypus*; but his account, unfortunately published without illustration, does not appear to have received general recognition.

With the aid of a new silver-staining method, an account of which is now in the press, I have recently obtained clear evidence for the regular occurrence of a single pair of Mauthner's cells in 22 mm. larvæ of *R. fusca*. With regard to the size and position of these cells, and the distribution of their dendritic processes, I am in agreement with the account given by Szepsenwol. The cells are best seen in thick (20–25 μ) transverse sections of the medulla, near the entry of the auditory nerve roots.

My observations on that part of the axon process which is usually described as 'Mauthner's fibre' differ considerably from Szepsenwol's description. The latter states that, in *R. fusca*, Mauthner's fibres are single processes. Against this, I have found that, before decussating, each fibre divides into two similar and thinner fibres. Each of these decussates separately with its fellow from the opposite side of the medulla, and becomes contralateral. The two decussations are equidistant from Mauthner's cells and occur one above the other. Posteriorly, the two contralateral fibres formed by each Mauthner's cell run beside the fasciculus longitudinalis medialis to the tail. In 22 mm. larvæ the Mauthner fibres are about twice as thick as the fibres of the fasciculus longitudinalis medialis, and have a more marked affinity for silver.

During larval life up to the 18–22 mm. stage (approximately), the growth of the Mauthner system is accompanied by the development of Rohon-Beard sensory cells, arranged as a dorsally situated column along the spinal cord. In later larval life, the growth of both these specifically larval components of the central nervous system is arrested. The Rohon-Beard cells rapidly undergo degeneration, while the Mauthner system persists without any further considerable differentiation.

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Jan. 21.

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[1] Szepsenwol, J., *C.R. Soc. Biol., Paris*, **118**, 44 (1935).

Ethical Aspects of the Development of Atomic Energy

BOTH the letter from Lionel Curtis in *Nature* of January 25 and the editorial article in the issue of December 21 appeal for "the fact-finding method of science" to be brought "into the political sphere"; but both, it seems to me, ignore the most significant fact in the world situation.

If it were true, in any immediate sense at least, that "The future of humanity depends on the three great Powers, not less than others, placing themselves strictly under the judgment and the surveillance of the rest of the world", then there would be no future for humanity. For such a dictum ignores the fact that one part of the world has, or is developing, a planned economy which involves great restriction or even abolition of the freedom of 'private enterprise', while the other part declares such freedom to be the essential core of civilization. There are intermediate positions, of course, but the two extremes, represented by the U.S.A. and the U.S.S.R., will not submit to each other's judgment in these matters.

A "strong international democracy" in such circumstances is impossible, and those who declare it to be essential merely make the side which would be in a minority, if such a democracy could be brought into existence, feel that the real intention is to impose on them an economic system they abhor. It is perhaps significant for a scientific investigator that all such declarations do, in fact, come from the side which would at present be in a majority.

I think such an international democracy will come into existence when the present polarization of social structure and ideas has ceased to exist. But that will not be in time to solve our present problems. What, then, can be done?

The essential thing is to see that the conflict which undoubtedly exists between the two parts of the world is resolved by friendly competition and not by armed force. At present it is only too obvious that each side suspects the other of attempting to achieve its domination by armed force. The great task facing us is to dispel that suspicion and create the conditions for peaceful rivalry between the two systems; to see which can, in the long run, give the common man more of the things, material and spiritual, which he desires.

What is required is a declaration by all the Powers that they will not use, make or keep a stock of atomic bombs or other weapons of mass destruction. While this is obviously insufficient by itself, it would help to allay suspicions and pave the way for general disarmament, in which the question of control of atomic energy would take its logical place along with the general control of disarmament.

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RELEASE OF INFORMATION ON ATOMIC ENERGY

IT is well known that the scientific work leading to the design of an atomic bomb was carried out under conditions of the strictest secrecy, and even fundamental scientific information obtained in this connexion was jealously guarded. It is natural that under post-war conditions much of this information can be released, but there are obvious difficulties in publishing it in the normal way.

The work was done as a joint project, shared by the American, British and Canadian Governments. Each country is considering its material independently, though on an internationally agreed basis as to what may and what may not be released. Most of the material is in the form of hastily written reports, and there is a reluctance on the part of authors to go back to this old material and to rewrite it in a form suitable for publication. Moreover, in many cases there would be independent publication of similar material from the United States or Canada. In view, too, of the continuing paper shortage, journals would find difficulty in publishing all the material, even if it were offered to them.

It has consequently been decided that where British information is declassified, copies of the reports shall be deposited in the Science Library at South Kensington, London, and the titles, of which a list follows, announced to the scientific public. So far as supplies permit, copies will be lent to responsible workers if they apply to the Technical Records Section, Department of Atomic Energy, Shell Mex House, Strand, London, W.C.2.

LIST OF BRITISH DECLASSIFIED REPORTS ON ATOMIC ENERGY

Title	Authors	Date
Investigation of the Delayed Neutron Emission from Fission Products, using a Modulated Source of Primary Neutrons	Feather, N.	August 1941
Streamline Flow through a Pipe of Rectangular Cross-section	Peierls, R.	November 1941
On the Possibility of a Slow-Neutron Chain Reaction	Frisch, O. R.	November 1941 (prior)
Separation of a Mixture of Three Components	Peierls, R.	November 1941 (approx.)
On the Counting of Neutrons using a Thick Layer of Hydrogen-rich Material and a 'Proportional' Counter	Feather, N.	March 1942
Directional Correlation in Fission Processes: Calculations relative to Possible Experiments	Feather, N.	April 1942
The Motion in a Self-fractionating Centrifuge	Dirac, P. A. M.	May 1942
Isotope Analysis of Uranium Samples by means of their α-Ray Groups	Frisch, O. R.	June 1942 (prior)
Absorption Measurements on the Radiations from $^{239}_{92}$U and $^{239}_{93}$X	Feather, N.	July 1942
Determination of Number of Neutrons emitted from a Source	Rotblat, J.	October 1942–January 1943
Note on the Theory of Supersonic Diffusers	Friedlander, F.	November 1942 (approx.)
Flow in the Gap between the Impeller and Diffuser	Friedlander, F.	January 1943 (approx.)
Energy Distribution of Fission Neutrons	Peierls, R.	November 1942 (approx.)
On a Modification of an Experiment suggested by Holt, Peierls and Frisch	Feather, N.	November 1942
The Blast Wave due to an Intense Explosion	Kynch, G. J.	December 1942 (approx.)
The Equation of State of Air at High Temperature	Fuchs, K. Kynch, G. J. Peierls, R.	[illegible]
Determination of the Total Neutron Collision Cross-Section for Hydrogen and Carbon	Bretscher, E. Murrell, E. B. M.	January 1943
The Ratio between Absorption Cross-Sections of B and H	Halban, H. Fenning, F. Seligman, H.	January 1943
Fluorinated Lubricants	Park, J. R.	January 1943
Some Theoretical Results on the Flow in Supersonic Diffusers	Friedlander, F.	January 1943 (approx.)
Use of a Small Boron Chamber for Measuring Absolute Yields of Neutron Sources	Kowarski, L. Bauer, S. G. Freundlich, H. May, A. N. Seligman, H.	January 1943
On a Shock Wave Problem Arising in the Theory of Supersonic Diffusers	Friedlander, F.	January 1943
Density Distribution near a Point Source	Peierls, R. Davison, B.	February 1943
Light Absorption by Two Black Hemispheres	Frisch, O. R. Peierls, R.	February, 1943
Regularities in Successive β-Disintegrations	Feather, N.	April 1943
Boundary Conditions in the "Modified Diffusion Theory" for the Neutron Density Distribution in Presence of a Container (incomplete)	Davison, B.	May 1943
” ”	”	March 1944
The Blast Wave due to an Intense Explosion	Howlett, J.	April 1943
On the Counting of the α-Particles emitted by "Semi-Thick" Layers of Uranium: Effect of the Variation of Stopping Power with Velocity	Feather, N.	June 1943
α-Particle Group Analysis using a Parallel-Plate Ionization Chamber: Effect of Variation on Stopping Power with Velocity	Feather, N.	June 1943
The Estimation of Deuterium in Water by the Temperature-Float Method	Bell, W. A.	July 1943
On the Flow of Gases through Expanding Pipes	Friedländer, F.	c. July 1943
Part I: Approximate Rate of Neutron Multiplication for a Solid of Arbitrary Shape and Uniform Density	Dirac, P. A. M.	August 1943
Part II: Application to the Oblate Spheroid Hemisphere and Oblate Hemispheroid	Dirac, P. A. M. Fuchs, K. Peierls, R. Preston, P.	
A Comparison of the Approximate Methods of Calculating the Critical Size of a Sphere	Wilson, A. H.	August 1943
The Loss of Energy by Fission Fragments at High Temperatures	Kynch, G. J.	July 1943
Physical Properties of Some φ-Compounds*	Haworth, W. N.	August 1943
Reduction in Neutron Density caused by an Absorbing Disk	Skyrme, T. H. R.	September 1943
Detector Response to Neutrons Slowed Down in Media Containing Cadmium	Broda, E. Hereward, H. Kowarski, L.	September 1943
Escape of Energy from a Cylindrical Ionisation Chamber	Skyrme, T. H. R.	October 1943
The Critical Radius and the Time Constant of a Sphere Embedded in a Spherical Scattering Container	Davison, B. Fuchs, K.	November 1943 (prior)
Critical Radius for a Hemisphere with a One-Sided Infinite Container	Davison, B.	November 1943
Differential Diffusion through a Capillary	Kynch, G. J.	December 1943
Measurement of the Concentration of U235 in a Sample of Uranium Oxide enriched in this Isotope	Kinsey, B. B. Cohen, S. J.	December 1943
Barium 139 as Fission Indicator	Broda, E.	December 1943
Szilard–Chalmers Effect in Permanganate Solutions	Broda, E.	January 1944
A Neutron Standard	Bretscher, E. Cook, G. B. Martin, G. R.	January 1944
Determination of the Number of Neutrons Emitted by a Radium–Beryllium Source	Bretscher, E. French, A. P. Martin, G. R. Poole, M. J.	c. February 1944

* Fluorinated compounds.

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The Effect of Small Departures from the Spherical Shape upon the Critical Size and Time Constant of a Sphere	Wilson, A. H.	March 1944 ✓
Alpha-Ray Analysis of X-Isotopes*. Part I. Apparatus	Clark, F. L. Spencer-Palmer, H. Woodward, R. N.	May 1944
Tests Concerning the Reproducibility of the $RaBeF_4$ Neutron Standard and its Calibration as a Source of Neutrons	Wilkinson, D. H.	June 1944
The Critical Size and Time Constant of a Spheroid	Fairbrother, H.	June 1944
The Energy Spectrum of the Neutrons from the Lithium (*p,n*) Reaction	Kinsey, B. B. Cohen, S. G.	June 1944 ✓
Critical Radius of a Hemisphere Completely Surrounded by a Container	Preston, P. D. Davison, B.	July 1944 ✓
The Effect of Anisotropic Scattering on the Multiplication in a Sphere	Wilson, A. H.	July 1944 ✓
Note on the Investigation of Spatial Asymmetry in Fast Neutron Fission, using a Double Ionisation Chamber and Pulse Analyser, and its Possible Bearing on the Problem of Large Capture Cross-Sections at High Energies	Feather, N.	July, 1944 ✓
Iodine 131 and 133 as Fission Indicators	Broda, E.	September 1944
On a Possible Method of Investigating the Back-Scattering of α-Particles under Conditions of "50 per cent Geometry"	Feather, N.	September 1944
On the Distribution of Pulse Sizes in a Parallel-Plate Ionization Chamber containing a Thick Layer of Hydrogen-Rich Material Irradiated with a Parallel Beam of Neutrons	Feather, N.	September 1944
On the Distribution of Pulse Sizes in a Parallel Plate Ionisation Chamber containing a Thick Layer of Hydrogen-Rich Material Irradiated with Neutrons (II): Effect of Oblique Incidence	Feather, N.	October 1944
A Rapid Colorimetric Method for the Determination of *T* in Solutions of TO_2F_2+HF, by means of Hydrogen Peroxide†	Smales, A. A.	November 1944
Chance Coincidences between Non-Random Sequences, with particular reference to Experiments using a Cyclotron Source	Feather, N.	*c.* January 1945
X-Ray Powder Patterns of some *X* Metal‡ Compounds	Peiser, H. S. Alcock, T. C.	March 1945
Upper Limits of the Fission Cross-Sections of Lead and Bismuth for Li-D Neutrons	Broda, E. Wright, P. K.	April 1945
The Range/Energy Relation for α-Particles of 0–5·3 MeV. in Ethylene and Polythene	Wilkinson, D. H.	May 1945
A Photographic Plate Study of Neutrons from the D-D Reaction	Livesey, D. L. Wilkinson, D. H.	May 1945
Differential Diffusion Through a Capillary (Part I. Mathematical)	Kynch, G. J.	*c.* June 1945
The Assignment of the Slow-Neutron-Produced Activities of Thallium and the Dual Disintegration of Radium E	Broda, E. Feather, N.	June 1945
Preparation of a Strong Thin Polonium Source and Preliminary Experiments on the Yield of (*α,n*) Reactions	Broda, E. Wright, P. K.	July 1945
Differential Diffusion through a Capillary, Part II	Kynch, G. J.	*c.* August 1945
Measurement of a Flux of Fast Neutrons with a Counting Pressure-Ionization Chamber	Allen, K. W.	August 1946
The Application of the Photographic Plate to the Quantitative Determination of Activities by Track Counts	Broda, E.	August 1946
The Permeability of Metals to Argon and Helium	British Non-Ferrous Metals Research Association	October 1946

* Uranium isotopes.

† *T* = uranium.

‡ Uranium.

SCIENTIFIC RESEARCH IN THE PACIFIC AREA

THE *Proceedings* of the Pacific Science Conference of the National Research Council, held at Washington, D.C., June 6–8, 1946, and now published as Bulletin No. 114 of the National Research Council (Washington, D.C.: National Academy of Sciences), includes reports of the opening addresses and of the various sessions, the specific and general recommendations of the Conference, the proposed organisation of the Pacific Science Survey and the recommendations relating to international co-operation.

The objectives of the Conference were to form an effective organisation of American men of science interested in the Pacific, to encourage and assist scientific research and activities in that area, and to further international co-operation along these lines. These objectives were detailed more specifically by Dr. Douglas L. Oliver at the opening session, and the permanent organisation which the Conference recommended the National Research Council should establish under some such name as the Pacific Science Survey contemplates six divisions, for anthropological sciences (including human geography), earth sciences, oceanography and meteorology, plant sciences, public health and medicine, and zoological sciences, respectively, each represented by a committee within the appropriate division of the National Research Council, the chairmen of these committees, with three others, constituting the Pacific Science Board. A co-ordinated programme of scientific research for the Pacific Islands, under American or foreign administration, has been formulated, and recommendations are detailed in the report under each of the divisional heads given above.

The pamphlet also includes a number of general recommendations regarding the release of materials and scientific information, the conservation of flora and fauna, and the use of insecticides, herbicides, etc., which might disturb the biological balance, the interchange of information on the physiology, biochemistry and biophysics of plants of importance in the Pacific area; and the establishment of base stations for scientific research in Hawaii, Guam and the Galapagos Islands, as well as floating stations, advance base stations for both marine and terrestrial research on various types of islands and at the extremes of environmental conditions and liaison stations in the Solomon Islands, Australian and Dutch New Guinea, French Oceania, Indonesia, the Philippines and the Galapagos. A survey of the state of our knowledge in the various fields of science in the Pacific, including a bibliography of the basic contributions, and documentation centres at Washington and Honolulu are also recommended.

Specific recommendations pertaining to international co-operation relate to the establishment of visitors' facilities at the principal centres, collaboration with interested institutions and individuals, American and foreign, in the preparation of a series of regional Floras, and encouragement of field-work in areas for which the data are inadequate. The establishment by the Government of the Netherland Indies of a scientific research station at Hollandia, Dutch New Guinea, is also recommended. Other matters discussed are the formation of international committees for the correlation and standardization of nomenclature and methods of measurement, extension of the survey of the Algæ and algal resources of Philippine and Indonesian waters to cover the Pacific, and the establishment of a scientific centre in the Philippines, supported by private funds.

FREE-PISTON COMPRESSOR-ENGINES

THE paper by H. O. Farmer on "Free-Piston Compressor-Engines", read before the Institution of Mechanical Engineers on December 6, must have been for many their first introduction to the subject, as this type of engine has received little publicity and has only just reached the production stage.

The free-piston compressor-engine, in its production form, is a reciprocating air compressor driven by a reciprocating two-stroke compression-ignition (or Diesel) engine. The outstanding feature is that neither the engine nor the compressor has the conventional rotating crankshaft; instead, the engine and compressor cylinders are arranged in line and the pistons are coupled directly. A normal engine has a flywheel which supplies the energy for the compression stroke; but in the free-piston engine, which has no flywheel, energy is supplied by the compressed air remaining in the compressor cylinder clearance space. This action is assisted in most free-piston engines by a separate 'cushion' cylinder with a closed end.

In order to improve the balance, there is usually a piston at each end of the engine cylinder, one being coupled directly to the compressor piston and the other to the 'cushion' piston; these two moving systems are coupled by a light linkage so that their displacements are equal and opposite. The underside of the compressor piston is used to pump scavenging air for the engine cylinder. This arrangement has all the very attractive features of the opposed-piston, two-stroke, supercharged, compression-ignition engine without the complication and expense of the connecting rods and rotating parts associated with conventional designs.

The amount of fuel injected is varied automatically by a governor so as to keep the output air pressure constant; the effect of varying the air demand being to change the stroke of the plant (the stroke is not fixed as in a normal plant). The frequency of the cycles remains nearly constant, and is 1,000 cycles per minute in one case quoted in the paper.

Starting is accomplished by bringing the engine pistons together suddenly. In small engines this is done by a spring, previously compressed manually through a handle and gearing; in larger engines a charge of compressed air is admitted to the 'cushion' cylinder. Another interesting detail is the method of driving rotating accessories such as the cooling fan and the water pump; the main reciprocating parts drive a plunger-type oil pump; this oil then drives a gear-type oil motor which provides the small power required.

A possibility which is being actively investigated is the use of a free-piston compressor-engine, instead of the usual rotary air compressor, in conjunction with a gas turbine for power purposes. The whole of the air pumped by the compressor cylinder is fed to the engine cylinder for scavenging and supercharging, and the hot exhaust gas, at comparatively high pressure, passes through a gas turbine. It is claimed that the very high overall efficiency of 41 per cent is obtainable.

Free-piston compressor-engines were largely developed by Pescara, who started work on them in France in 1922. In Great Britain their development was encouraged by the Services; the first engines were ordered for the Navy and later ones for the Army.

TREPHOCYTES AND TREPHOCYTOSIS

DR. LIEBMAN'S monograph, "On Trephocytes and Trephocytosis; a Study on the Role of Leucocytes in Nutrition and Growth" (*Growth*, **10**, 291; 1946), concerns a neglected field of invertebrate hæmatology, and combines a comprehensive review of the literature with a record of his own extensive studies. Attention is focused on leucocytic elements that contain inclusion bodies (granules, spherules and pigment), but which, according to the evidence, have no phagocytic function. The author advances a well-substantiated view that the inclusion bodies are elaborated inside these cells, which he calls 'trephocytes', and that they are discharged and utilized as nutrient material in regions of increased metabolic activity. Hence the concept of trephocytosis, which is thought to be the main function of these cells, as opposed to phagocytosis, which, in the author's opinion, may well be the main task of hyaline 'lymphoidocytes'. On the comparative side, a parallel is drawn between the trephocytes of invertebrates and the mast cells of vertebrates.

The attitude of the author is characterized by a justified reluctance to apply, without reservation, the teleological line of thought imposed by mammalian 'defence' physiology and, consequently, a caution in attributing phagocytic properties to elements which do not seem to possess any.

Of particular interest are the author's current studies in Tunicates, and especially his observations made in Sipunculids and Polychætes, where some blood cells reveal intermediate characteristics between leucocytes with inclusions and erythrocytes. A more detailed account of this work may well prove of great value for comparative hæmatology.

FORTHCOMING EVENTS

Monday, March 31

Palæontographical Society (in the Geological Survey Museum, Exhibition Road, London, S.W.7), at 11 a.m.—Centenary Meeting; Prof. H. L. Hawkins, F.R.S.: Commemorative address: at 2.30 p.m.—Mr. C. P. Chatwin: "The Story of Fossils".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Developments in Fractional Horse-Power Motors" (to be opened by Mr. A. N. D. Kerr).

Tuesday, April 1

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—A representative of the Mond Nickel Co., Ltd.: "Isothermal Transformations".

Television Society (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2).—Annual General Meeting.

Wednesday, April 2

Institute of Fuel, North-Western Section (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Annual General Meeting.

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Institution of Civil Engineers, North-Western Association (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. F. N. Sparkes: "Some Defects in Concrete Roads—Causes and Remedies".

Society of Dyers and Colourists, Midlands Section (in Room 104, College of Art and Technology, Leicester), at 7 p.m.—Dr. G. L. Royer: "Studies on Wool Dyeing: Comparison of Methods for Applying Chrome Dyes".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer or **Lecturer in Soils and Manures**, and an **Assistant Lecturer in Biochemistry**, at the Massey Agricultural College, Palmerston North—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 9).

Senior Lecturer and a **Lecturer in the Department of Anatomy**—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (April 15).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 1335: 1946. Air-Depolarised Primary Cells. Pp. 16. (London: British Standards Institution, 1946.) 2*s.* net. [312

Department of Scientific and Industrial Research: Road Research. Special Report No. 3: Roadstone—Geological Aspects and Physical Tests. By Dr. J. Phemister, E. M. Guppy, A. H. D. Markwick and F. A. Shergold. Pp. iv + 42. (London: H.M. Stationery Office, 1946.) 9*d.* net. [312

Amgueddfa Genedlæthol Cymru: National Museum of Wales. Thirty-ninth Annual Report, 1945–46. Pp. 38. (Cardiff: National Museum of Wales, 1946.) [412

Physical Society. Report on Defective Colour Vision in Industry. By a Committee of the Colour Group. Pp. 52. (London: Physical Society, 1946.) 3*s.* 6*d.* net. [412

Department of Scientific and Industrial Research: Forest Products Research. Bulletin No. 20: Requirements and Properties of Adhesives for Wood. By R. A. G. Knight. Pp. vi + 26. (London: H.M. Stationery Office, 1946.) 6*d.* net. [512

Scientific Film Association. The Classification, Appraisal and Grading of Scientific Films. Pp. 18. (London: Scientific Film Association, 1946.) 2*s.* 6*d.* [512

Reports on Fuel Economy since 1939—British National Committee. Pp. 52. (London: World Power Conference, 1946.) 1*s.* 6*d.* net. [912

Imperial Institute: Mineral Resources Department. Nigeria: Geology and Mineral Resources. By Dr. F. Dixey. (Reprinted from the *Bulletin of the Imperial Institute*, Vol. 43, No. 4, October–December 1945.) Pp. 18 + 4 plates. (London: Imperial Institute, 1946.) 1*s.* net. [912

Signposts to Better Filtration: to Assist Chemists in the Selection of Filter Papers. Prepared by A. McM. Taylor. Pp. 20. (Maidstone: J. Barcham Green, Ltd., 1946.) 2*s.* 6*d.* net. [912

British Society of Animal Production. Report of Proceedings, Fifth Meeting, 26th February 1946, General Topic: Breeding Methods in Livestock Improvement; Open Meeting, 27th February 1946, General Topic: Artificial Insemination. Pp. 94. (Aberystwyth: British Society of Animal Production, University College of Wales, 1946.) 3*s.* [912

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Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 16, No. 2, September. Compiled by Agnes Elisabeth Glennie, assisted by Diana Margaret Studdert Holmes. Pp. iv + 75–162. (London: H.M. Stationery Office, 1946.) 4*s.* 6*d.* net. [912

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 2, No. 17: The Genus Primula, Sections Obconica, Sinenses, Reinii, Pinnatae, Malacoides, Bullatae, Carolinella, Grandis and Denticulata. By Sir W. Wright Smith and Dr. H. R. Fletcher. Pp. 415–478. (Edinburgh and London: Oliver and Boyd, 1946.) 16*s.* [1212

German Educational Reconstruction. No. 5: Public Libraries in Germany. By Heinz Schurer. Pp. 24. (London: German Educational Reconstruction, 1946.) 1*s.* 6*d.* net. [1212

Department of Scientific and Industrial Research: Forest Products Research Laboratory. Leaflet No. 40: The Preparation of Wood for Microscopic Examination. Pp. 8. (Princes Risborough: Forest Products Research Laboratory, 1946.) Free. [1212

Colonial Office. Memorandum on Colonial Mining Policy. (Colonial No. 206.) Pp. 10. (London: H.M. Stationery Office, 1946.) 2*d.* net. [1212

University of Leeds. Report of the Librarian for the Session 1945–46. Pp. 8. (Leeds: The University, 1946.) [1612

Post-War Building Studies. No. 20: Fire Grading of Buildings. Part 1: General Principles and Structural Precautions. By a Joint Committee of the Building Research Board of the Department of Scientific Research and of the Fire Offices' Committee. (Published for the Ministry of Works.) Pp. 116. (London: H.M. Stationery Office, 1946.) 1*s.* 6*d.* net. [1612

British Chemicals and their Manufacturers: the Official Directory of the Association of British Chemical Manufacturers, Inc. Pp. 121. (London: Association of British Chemical Manufacturers, 1946.) Free. [1612

British Commonwealth Scientific Official Conference, London 1946. Report of Proceedings. (Cmd. 6970.) Pp. 73. (London: H.M. Stationery Office, 1946.) 1*s.* 3*d.* net. [1712

Experimental and Research Station, Nursery and Market Garden Industries' Development Society, Ltd. Thirty-first Annual Report, 1945. Pp. 98. (Cheshunt: Nursery and Market Garden Industries' Development Society, Ltd., 1946.) [1812

Medical Research Council. Special Report Series, No. 258: The Preservation of Proteins by Drying, with Special Reference to the Production of Dried Human Serum and Plasma for Transfusion. By Dr. R. I. N. Greaves. Pp. v + 54 + 20 plates. (London: H.M. Stationery Office, 1946.) 2*s.* net. [1912

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Bergens Museums Årbok: Naturvidenskapelig rekke. 1938, Hefte 2, Nr. 5–11. Pp. 122 + 2 plates. 1939–40, Hefte 1, Nr. 1–6. Pp. 277 + 34 plates. 1939–40, Hefte 2, Nr. 7–8. Pp. 215 + 4 plates. 1941, Hefte 1, Nr. 1–5. Pp. 192 + 3 plates. 1941, Hefte 2, Nr. 6. Pp. 236. 1941, Hefte 3, Nr. 7–11. Pp. 202 + 1 plate. 1942, Hefte 1, Nr. 1–5. Pp. 131. 1942, Hefte 2, Nr. 6–9. Pp. 262 + 8 plates. 1943, Hefte 1, Nr. 1–7. Pp. 192 + 6 plates. 1943, Hefte 2, Nr. 8–11. Pp. 186 + 10 plates. (Bergen: A/s John Griegs Boktryckkeri, 1940–1944.) [2811

Bergens Museums. Skrifter Nr. 20: Geology of the Bergen Arc System. By Carl Fred. Kolderup and Niels-Henr. Kolderup. Pp. 137 + 14 plates. 20 kr. Skrifter Nr. 22: Sikilsdalen og Norges fjellbeiter, en plantesosiologisk monographi. Av Rolf Nordhagen. Pp. xvi + 607. 30 kr. (Bergen: A/s John Griegs Boktryckkeri, 1940–1943). [2811

Uganda Protectorate. Annual Report of the Geological Survey Department for the Year ended 31st December 1940. Pp. 35. 2*s.* Annual Report of the Geological Survey Department for the Year ended 31st December 1941. Pp. 34. 2*s.* (Entebbe: Geological Survey Department, 1941–42.) [312

Indian Forest Leaflet. No. 71: A Note on the Species of South Indian Wattles. By M. V. Edwards. Pp. ii + 9. 4 annas. No. 73: The Vegetable Tanning Materials of India, Part 2, Avaram (*Cassia auriculata* Linn.) By M. V. Edwards. Pp. ii + 21. 8 annas. No. 75: The Vegetable Tanning Materials of India, Part 4, Myrobalan (*Terminalia chebula* Retz.) By M. V. Edwards. Pp. ii + 19. 8 annas. (Dehra Dunn: Forest Research Institute, 1945.) [912

Crohamhurst Observatory. Observatory Paper No. 12: The Elements of Crohamhurst, 1892-1942. By Inigo Jones. Pp. 19. (Crohamhurst: Crohamhurst Observatory, 1942.) [912

U.S. Department of the Interior: Geological Survey. Bulletin 945-G: Chromite Deposits of the North Elder Creek Area, Tehama County, California. By G. A. Rynearson. (Strategic Minerals Investigations, 1944.) Pp. iv + 191–210 + plates 65–70. n.p. Bulletin 947-B: Molybdenite Investigations in Southeastern Alaska. By W. S. Twenhofel, G. D. Robinson and H. R. Gault. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iv + 7–38 + 8 plates. n.p. Bulletin 947-C: Nickel Investigations in Southeastern Alaska. By George C. Kennedy and Matt S. Walton, Jr. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iv + 39–64 + plates 9–18. 15 cents. Bulletin 947-D: Geology and Associated Mineral Deposits of some Ultrabasic Rock Bodies in Southeastern Alaska. By George C. Kennedy and Matt S. Walton, Jr. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iii + 65–84 + plates 19–22. 10 cents. Bulletin 947-E: Copper Bullion Claims, Rua Cove, Knight Island, Alaska. By Karl Stefansson and Robert M. Moxham. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iii + 85–92 + plates 23–25. 10 cents. Bulletin 947-F: Copper Deposits of the Nizina District, Alaska. By Don J. Miller. (Mineral Resources of Alaska, 1943 and 1944.) Pp. iii + 93–120 + plates 26–29. 15 cents. Bulletin 947-G: Copper Deposits of the Kotsina-Kuskulana District, Alaska. By Ralph E. Van Alstine and Robert F. Black. (Mineral Resources of Alaska, 1943 and 1944.) Pp. ii + 121–142 + plates 30–32. 15 cents. Bulletin 950: Contributions to Geochemistry, 1942–45. Short Papers by R. C. Wells and others. Pp. vi + 162 + 5 plates. 40 cents. (Washington, D.C.: Government Printing Office, 1946.) [912

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USE OF THE LAND IN BRITAIN

SINCE the appearance in 1944 of the White Paper on the utilization of land issued by the Coalition Government, it has been fairly certain that any proposals for a central planning authority and for dealing with the difficult problems of compensation and betterment advanced by the Government of the day would be controversial. Of the Planning Bill introduced by Mr. Silkin, it must be said that while it goes a long way towards establishing a workable system planning the use of the land and meeting the fundamental requirements, it is not unreasonably controversial. Dispute as to the price the community should pay for extinguishing the development rights of private owners of land does not alter the plain fact that the extinction of those rights removes the largest single impediment to planning of the use of land on national lines. Moreover, the decision not to transfer to national ownership all land about to be developed, as was recommended by the Uthwatt Committee, and to levy a betterment charge only when a change of land use occurs, in place of a levy on all increments of site value, may add indirectly to the cost of good planning but should not seriously hamper it. The planning sections of the Bill appear to concede virtually all that planners and local authorities have demanded for a generation, and the wide extension of Exchequer grants to local authorities should banish the last remaining fear of local authorities that the policy of systematic urban dispersal, extension of open space in central areas, and the conversion of land to more socially valuable uses, although less remunerative financially, will involve them in financial losses and compensation charges which they cannot face.

Amid the mass of detail with which we are not appropriately concerned here, there are at least two points which claim attention. The first of these concerns the basis of planning. Development without prior permission is in future prohibited, even when a local planning authority is to be responsible for development. Every local planning authority must first survey the area and prepare a development plan indicating the manner in which it proposes that land in that area should be used, and the stages by which any such development is to be carried out. The planning process is to be flexible, dynamic and positive, and doubts as to the adequacy of the unified control proposed were largely—but not entirely—resolved by Mr. Silkin's declaration, in moving the second reading of the Bill, of his intention to use fairly freely his power to create joint planning boards from the one hundred and forty-six counties and county boroughs which are to be the main and primary planning instruments.

These authorities are given three years in which to prepare their broad development plans. Such plans are to show which towns and villages are suitable for expansion, and which can best be kept to their present size ; the direction in which a city will expand ; the area to be preserved as an agricultural green belt and the area to be allotted to industry and to housing. In filling in the detail over smaller areas, when development is about to take place, much of the work of enforcement and detailed control will be delegated to the smaller authorities. The central authority will knit development plans into regional and national patterns and will participate in all stages of planning, and local authorities must reconsider their plans at least once in every five years.

While, however, the local authorities are given the legal powers to march with their new responsibilities, as well as the financial resources, there can be no question as to the strain which will be imposed upon many of them, and the first question that arises is the provision of adequate trained staff to discharge the new planning functions and responsibilities. It was stated in the debate that local authorities already need 1,800 more men with technical architectural knowledge than they can get—a figure equal to the total membership of the Town Planning Institute, including students. This is a fresh demand on trained man-power which cannot be ignored, even if in some areas a great deal has already been done to provide the basic surveys required. It will be essential for the local and regional planning authorities to make the fullest possible use of such local surveys by voluntary bodies and to foster further surveys by such bodies as Nuffield College, the West Midland Group on Post-War Reconstruction and Planning, the Northern Industrial Group, and local universities.

The three years in which the local authorities have to prepare development schemes will clearly be too short, even if no difficulty were likely to be experienced in recruiting the additional planning staff and in training that staff in a new tradition which will equip them to understand and to mould the social and economic fabric of the nation, unless the fullest possible help and co-operation is secured from the many who are willing to give it. Mr. Silkin himself recognized the need for associating the universities in particular, not merely with the training of the new type of planner required to carry out this broader conception of planning, but also with research into the economic and social problems of their surrounding areas, as has been done earlier by the Board of Trade. Due regard must, of course, be had to the proper limits of academic studies; but even so, this may be much the most important contribution that the universities can make in the immediate future to the planning of Britain, apart from their continuing function of supplying the nation with men and women trained to take balanced views and imaginatively alive to the human no less than to the technical issues in the problems with which they are called upon to deal.

We can scarcely expect the universities to make an immediate contribution to the supply of the large numbers of new town-planners who will be required, for the University of Durham alone provides a degree course in town and country planning. Indeed, not many of them are likely to be university graduates. Nevertheless, as Mr. Silkin rightly said, the co-operation of economists, geographers, sociologists and others will be required, and the universities can do something more to promote that informed and interested public opinion which is an essential condition of good planning, as well as the supply of first-rate administrators to give effect to the plans. The Bill might well have contained more evidence of the Minister's desire for such co-operation. The immense amount of material which the Bill contains is a further reason for affording the ordinary citizen ample opportunity to express his views. There could be no greater mistake than to attempt to curtail public discussion and informed criticism of the many complex issues which are raised.

The importance of such public discussion is enhanced by a second feature of the Bill which should be noted by scientific workers because of its implications for them. Comprehensive as are its planning provisions, and thoroughly as they remove the main obstacles to the rational and orderly development of the land of Britain—the compensation bogey, the lack of finance for local authorities, the absence of powers of State planning and development—there is one serious omission. Land held by Government departments, except when leased to private persons, will escape all local planning control, and the Minister himself has no authority over the use of land by other Government departments or by statutory undertakings, and no control over the location of industry. There is no provision for harmonizing the planning activities of the many Government departments which will retain power to acquire land, or to reconcile differences regarding the use of land between the Ministry responsible for planning and such departments; and inasmuch as the control of the location of industry is by the Bill itself to be vested in the Board of Trade, the influence of the Board on the planning and development of the community may be as great as that of the Ministry of Planning itself.

How serious is such a position has been well brought out in the recent inquiry into the proposal to dam Ennerdale Water, and in the current debate regarding the acquisition by the Services of land for training areas. The Standing Committee on National Parks, which represents the Councils for the Preservation of Rural England and Wales and the Friends of the Lake District, in a statement on the order concerning Ennerdale Water, which comes inside the Lake District national park, has indicated the perfunctory treatment which public issues may receive at the hands of a department, and the way in which the technical factors may be disregarded. The fate of Ennerdale at the hands of the Minister of Health indicates how slender are the prospects for national parks anywhere if the Ministry of Town and Country Planning remains merely one among several departments with no overriding powers.

The same point is made in a statement on Services training areas which has since been issued by the Standing Committee on National Parks. While the statement is chiefly concerned to direct attention to the necessity for protecting potential national park areas from any form of development inconsistent with their ultimate use when the necessary legislation is secured, it is of interest here as indicating the limitations of the method of handling the claims of the Services piecemeal before the Inter-Departmental Committee. That Committee can do no more than consider each case in isolation as it comes before it, and report to a committee of the Cabinet on unresolved claims. There is no provision for the consideration of the claims as a whole, still less of the possibilities of co-ordinating and combining claims of different Services and commands and establishing principles by which individual cases can be decided; nor, more important still, for examining the allocation of the total land resources of the country to agriculture, industry, military training, electric power and water supply and popular enjoyment. If that is too large a question to be entrusted to an individual Ministry such as that of Town and Country Planning, it might well be examined by a Select Committee of both Houses of Parliament, as the National Parks Committee recommends. The imperative need for some such body with powers to enforce decisions even on recalcitrant Government departments could scarcely be better illustrated than by the decision of the War Office to retain 238 acres of London's 'green belt' near Coulsdon and Purley for a bombing range. The most perfunctory study of the Land Utilization Survey's map of Great Britain, or of the admirable population maps published for the Ministry of Town and Country Planning, should convince anyone of the need for reconsideration of such proposals.

One of the biggest questions is, in fact, whether the Bill as at present drafted provides machinery of national planning powerful enough to withstand an interested department. The decision should clearly not rest, for example, on whether the capacity of the War Office for passive resistance is stronger than the political importance of London local authorities; it should depend on an unbiased consideration of the best use of the nation's land, and proper safeguards to that end should be provided. It is disturbing to note that Mr. H. D. Hughes's specific question on this point in the debate in the House of Commons on the second reading of the Bill was unanswered when the Chancellor of the Exchequer wound up for the Government.

The incorporation of such over-riding and co-ordinating powers would, however, enhance the importance of the factor on which the efficacy of the whole Act will finally depend—the wisdom with which the control embodied in the Act is exercised. It was well said in the debate, by Mr. J. H. Hare, that the success or failure of the Bill, as it stands, must depend very largely on the wisdom, the integrity and the intelligence of those who are required to administer it. That is the point of most vital interest to the individual citizen, and the answer depends primarily on the quality of the administrator to whom the exercise of the new powers is entrusted. This is an issue transcending all party divisions. Agreed decisions on the financial provisions and on other procedure will not enable the Act to achieve its purposes unless it is administered with wisdom, dispatch and restraint. Indeed, one important reason for welcoming and fostering co-operation in the preparation of schemes contemplated in the Bill is that it should also assist in the training of administrators for that work, and in embuing them with the imaginative insight and understanding of the needs of the public, its comfort and convenience, which it should be the first object of public administration to study and to serve.

MECHANISM OF COLOUR VISION

Retinal Structure and Colour Vision

A Restatement and an Hypothesis. By Dr. E. N. Willmer. Pp. xii + 231 + 4 plates. (Cambridge: At the University Press, 1946.) 21*s*. net.

THE organ of sight continues to challenge imagination and experimental initiative and so maintains its position as one of the most fascinating living structures in existence, and at the same time the source of so much of our most important knowledge about life and matter. The list of British men of science who have made notable contributions to this field is as impressive as that of any other country. It begins with Newton, whose ideas inspired Thomas Young (according to the latter's own words). Brewster, Maxwell, Dalton, Lord Rayleigh made discoveries which are classical. From our own period one need but mention Adrian's brilliant pioneer work on optic nerve impulses, Lythgoe's discovery of transient orange, Stiles' of the directional sensitivity of the retina, and Wright's analysis of the fundamental trichromatic response curves to realize that the tradition is being maintained.

The latest contribution comes from a Cambridge histologist, Dr. E. N. Willmer. It is right that histologists should add their word to the discussion, since physiology has now reached the point at which further advance in our knowledge about the function of the retina must contain new histological terms. There are the well-known receptors, the rods and the cones, which have long been on the stage, probably too long, when one considers that to the receptors is attached a true nervous centre, exceedingly complex, and certainly of fundamental importance for the interpretation of the world around us in terms of brightness discrimination, general light perception and colour. Nature's idea, to project a piece of the central nervous system on to the periphery and thus make it easily accessible to adequate, localized and controllable stimulation, is a hint meant to be taken.

Dr. Willmer approaches his theme in an unorthodox manner. He does not accept the idea, implicit in so much of modern psychophysical work in this field, that there are three kinds of cones, for the perception of red, green and blue colours. He thinks that the cones only are responsible for the long wave-lengths, whereas the green and the blue regions are transmitted by two kinds of rods. In the human fovea there is only the 'green' kind of rod, a day-rod, to which he attributes a sensitivity curve corresponding to the scotopic luminosity curve. This necessitates the further assumption that the 'green' day-rod contains visual purple in some less-adaptable or less-spurious form, since our scotopic luminosity curve is certainly determined by the photochemical properties of visual purple. The choice of ordinates for the response of the cone (the red receptor) has given him greater difficulties owing to the accumulation of physiological evidence on this point which he has felt bound to observe. He then proceeds to construct a colour chart with his rod- and cone-response curves, compares it with the C.I.E. chart and several other properties of colour vision: altogether a very ingenious, stimulating and, besides, entertaining account of what the mechanism would look like if it had the fundamental response curves which he attributes to it.

Unorthodoxy in this matter, if it is to serve any purpose, can only be of interest if the theory propounded is properly worked out so that one can perceive its merits, deficiencies and value as a stimulus. From this point of view Dr. Willmer's work deserves high praise. In assessing its value as a truthful account of the mechanism of colour vision one must examine separately its two fundamental propositions. The first states that the green and blue regions of the spectrum are perceived by rods. There is a great deal of electrophysiological evidence in favour of this view to which I would like to subscribe myself, in the form that there certainly is a very intimate connexion between rods and colour reception in the short wavelengths. There is also evidence for a great range of variation in the adaptability of the rods, day-rods and properly dark-adapting rods, the latter utilizing the full visual purple sensitivity. Conversely, an intimate connexion exists between cones and red-sensitivity. Willmer's second fundamental assumption consists in ascribing to the day-rods the visual purple distribution of sensitivity. For this view there is no evidence; in fact, such evidence as exists rather suggests that part of the visual purple under the influence of illumination splits into blue and green elementary colour bands with maxima to either side of its own maximum in 500 mμ. In animals, single fibres can be found which respond in this manner. The pure cone eye of the snake has its maximum green sensitivity around 520–530 mμ. The electrophysiological work on single fibres in animals gives a more detailed picture of the retinal mechanism of colour reception than work on man, in fact, several narrow bands; but the spectral loci of the integrated colour bands responsible for red, green and blue reception are in essential agreement with the loci of the fundamental response curves which Wright and his collaborators have been forced to accept as the most probable ones (see, for example, W. D. Wright, "Researches on Normal and Defective Colour Vision, Kimpton, London, 1946). The latter, of course, are averages.

Of Dr. Willmer's two assumptions the first one, therefore, seems to me of greater interest and destined to survive as a starting point for experimentation. Psychophysical work on vision and, in particular, on colour vision tends to be conservative in methods and problems. It scarcely ever aims at an understanding of retinal processes going beyond the simple scheme of response curves attributed to three types of cones. Dr. Willmer is performing a real service to his subject by demonstrating the need for taking up points of view which arise from a consideration of the histological structure of the retina and the physiological experiments directed towards interpreting it in functional terms. He is, for example, rightly concerned with the very fundamental problem as to what use the retina makes of its mechanisms of inhibition, what it signifies that in certain circumstances light does not elicit impulses at all but, on the contrary, stops them. If Dr. Willmer, in pursuing his subject, would turn his gifts of imagination and perseverance into experimental channels he would, no doubt, be able to suggest several interesting ways of studying rods and cones in relation to that little nervous centre placed at the end of the optic nerve just behind the layer of receptors. In view of a few very interesting experiments, found in his stimulating book, this would seem to be a safe forecast.

RAGNAR GRANIT

FROM AQUINAS TO EINSTEIN

Space and Spirit

Theories of the Universe and the Arguments for the Existence of God. By Sir Edmund Whittaker. Pp. vii + 150. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1946.) 6*s*. net.

SIR EDMUND WHITTAKER here gives the substance of his Donnellan Lectures delivered in June 1946 in Trinity College, Dublin; and the closing words of the book express its aim, namely, to indicate "that the deeper understanding of the nature of the material universe, which has been achieved by scientific discovery, has opened up new prospects and possibilities to the advocate of belief in God".

Sir Edmund holds that the line of descent of the modern physicist is from the Schoolmen of the twelfth and thirteenth centuries who translated into Latin the Arabic versions of Greek mathematics and science, and were Aristotelians, attaching meaning and value to the concrete things of sense and relying upon experience. Herein they were innovators and modernists, rejecting the Neoplatonist philosophy, dominant since Augustine, for which the material world of sense was the lowest and vilest element in the scheme of things. Aquinas' famous five proofs of the existence of God have their starting point in experience and are grounded in Nature.

Radical changes in physical theory have taken place since Aquinas elaborated his arguments, changes associated with the names of Copernicus, Kepler, Galileo, Descartes and Newton. Then in their turn the classical physical theories of Newton have been subjected to radical criticism and modification in view of the principles of relativity and of quantum-mechanics. Thus one might expect to find little that is relevant to-day in the Schoolmen's reasonings.

In one respect indeed their attitude differed from that which has been general since the Renaissance; they strove to understand the purpose behind events rather than to discover the laws of their operation. Yet the real difference is not so great as might appear, since to regard natural objects as striving to accomplish some purpose is only a naïve way of saying that their behaviour is not haphazard or lawless. Either formulation of the initial assumption would serve the purpose of Aquinas' argument. Indeed, it is in some respects reinforced by recent developments. For example, the ability of the mathematician to predict the existence of wholly new and unexpected phenomena in the external world reveals an order in Nature which transcends the range of experimental facts. Einstein's predictions of the bending of light-rays by the sun's attraction is a case in point. Again, recent researches have led to the conclusion that the universe cannot have existed for an infinite time in the past, at any rate under the laws of Nature as we know them. This re-introduces the idea of a creation, established by rational science, and not, as held to be the only possible way by Aquinas, by revelation. Moreover, the fact, unknown to Aquinas, that the *same* mathematical laws are valid over the cosmos, leads to the inference that there is only a *single* mind involved in the whole creation. In short, "the proof from Order is to-day more complete, more comprehensive, and more majestic than in the form in which it was presented in the thirteenth century".

Those who are interested in the bearing of modern physical theories upon ultimate problems will highly value this lucid and original book.

J. C. HARDWICK

ORIGINS OF WATER TRANSPORT

Water Transport

Origins and Early Evolution. By James Hornell. Pp. xv + 307 + 45 plates. (Cambridge: At the University Press, 1946.) 30*s*. net.

MR. HORNELL has accomplished a valuable work in preparing this account of how mankind conceived and made use of floating structures in order to traverse stretches of water. His research is confined to the evolutionary period down to the sailing ship; details of construction are reviewed and distribution in time and space recorded.

Relatively little is known of man's greatest achievements; his written history is but the history of yesterday, and the most significant advances—such as the development of speech—were prehistoric. If the source of European civilization can rightly be traced to certain amphibious tribes who dwelt on the coast of the Mediterranean, raising the piles of their houses in the water so to escape the greater perils of the land, then some kind of rudimentary navigation was the prime condition of human progress, and the importance of that development is transcendental. Mr. Hornell deals with primitive watercraft in three main groups: (*a*) floats, rafts and kindred craft; (*b*) skin boats: coracles, curraghs, kayaks and their kin; (*c*) bark canoes, dugouts and plank-built craft. Groups (*a*) and (*b*) have each five chapters covering the evolution; group (*c*) carries nine chapters and reflects to some extent the background of human aspiration—social, religious and economic—which was the cause of the technical development. Here the genetic relation of the bark canoe to dugouts and plank-built boats is considered, and the author, while re-stating his conviction that the boats of clinker and carvel build in use in Europe to-day are derived ultimately from the dugout canoe, observes that the genesis of many current types of dugout was the imitation in wood of the form of a canoe made from a sheet of bark. This implies that the origin of actual boat construction must be moved back much further in time, because the ancient forest people—regarded as the first 'human' ancestors—were restricted to the rudest of stone tools and yet, it is inferred, were capable of stripping the bark from trees, and by the use of a long strip curled up at each side, with the ends stopped by clay, were able to navigate the waters. The hypothesis derives support from the material culture of the Australian aborigines to-day, which can be little if at all advanced beyond that of our ancestral forest dwellers, and among whom all the relevant gradations in canoe design have been found. The possibility that dugouts evolved independently in some localities cannot be excluded, and, as the author remarks, the genetic relationship will probably remain an open question for all time.

Transition from the dugout to the carvel-built ship is more easily determined. The fashioning of the former was primarily a matter of patient labour, even when fire was used, but where large timber was available, the dugout might assume sea-going proportions. Increase in the freeboard of dugouts by the addition of a washstrake certainly marked the first stage, and in certain types the strakes—in the form of rows of superimposed planking—were sewn edge to edge and a strengthening frame was inserted. Bending of the sides outwards to obtain greater beam; insertion of wedged cross-bars to preserve the flare, and its continuation by a deep washstrake; and, finally, reduction of the underbody to the form of a keel member were further stages.

The historic differentiation between the techniques of carvel and clinker build is elucidated, and also the Mediterranean origin of the former. It is significant that all boats there and in the Indian Ocean are so built, whereas the clinker build is found only in the seas of north Europe. The determining of prototypes is here obscure: that the latter should have derived from a raft with built-up sides seems credible; but rafts were not used in the bleak northern seas, and we must look to the dugout canoe as the precursor of clinker build, the essentials of which have persisted since Viking times.

In the final chapter, primitive belief in the need for intimate association between a protective god and watercraft is discussed—in particular, the prow of the ship as the sanctuary of its tutelary deity. This superstition takes the form of definite and often periodic worship, with suitable offerings, of a protective deity there located, and of traditional acts performed to ensure immunity from the effects of the evil eye—possibly the source of the Christian practice of blessing aeroplanes and other vehicles. Mr. Hornell observes that the rites are often intermingled and cannot therefore be considered separately; most of the instances he cites come within his own personal knowledge. Dedication, with elaborate ceremonies, of a vessel to a goddess who would abide in it, and be its protectress during voyage across the sea, is described; the final rite consisted of the incision of an eye on each bow—the ceremony of the 'opening of the eyes'. This 'cult of the oculus' is still widespread; originally it symbolized the deity's eyes watching for danger, but became debased to a mere amulet. The sacrificial ceremonies connected with launching, and the various rites associated with placating a deity when becalmed, are discussed from abundant data at the author's command. Out of this inquiry little emerges that is satisfying to the technical reader, but the association of the stemhead with such rites is interesting.

It is true, as the publishers say, that the book could not have been written without first-hand knowledge; and in this the author's qualifications are exceptional, for he has travelled all over the world and examined most of the craft he describes and observed their daily use. His investigation was thus carried out in a scientific manner; and when to this scholarship is added, the result cannot be other than illuminating. The book is profusely illustrated by photographs and text-figures and is extremely well documented. Recent distribution of eight categories of primitive craft is shown on Mercator's projection.

M. J. B. DAVY

Sun, Moon and Stars

Astronomy for Beginners. By Prof. William T. Skilling and Robert S. Richardson. (Whittlesey House Publication.) Pp. viii+274. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 12*s.* 6*d.*

THE authors of this book are well equipped for producing a work that will appeal to young people—and one might add to older people, too, who have little or no scientific background. Prof. Skilling has taught astronomy for many years and Dr. Richardson, at present associated with the Mount Wilson Observatory, has devoted a number of years to research. Five parts deal in turn with "The Moon", "The Sun", "The Sun's Family of Planets", "The Stars", and "Astronomers and Observatories", and the subjects are treated in a manner which requires practically no mathematics, or where such is introduced, it is of the most elementary character. The descriptions are excellent for the readers for whom the book is intended, and are illustrated by ninety-nine diagrams and photographs.

The work has been produced primarily for American readers, but it will probably have a good circulation among British readers as well. For this reason it is suggested that a new edition might contain certain amendments where the text is directed specifically to American readers and may mislead others (pp. 48, 109, 165).

A few other points require attention. The reference to the rising of the full moon in September (p. 37) does not apply for all latitudes; and the old theory about the apparent enlargement of the moon when close to the horizon (p. 42) is no longer held. The corona can now be seen without a total solar eclipse (p. 87). It might be inferred (p. 107) that the tidal theory of the origin of the solar system is generally accepted, but it would be more correct to say that it was generally rejected; and the view that swift meteors are hyperbolic (p. 164) is no longer held. These are very minor blemishes which do not detract from the value of a most readable and informative book. M. Davidson

Exploring Nature with a Camera

By Ernest G. Neal. Pp. 103+62 plates. (London: Paul Elek (Publishers), Ltd., 1946.) 10*s.* 6*d.* net.

BIRD photography has reached such a pitch of excellence, its devotees are so many and so enthusiastic, that we are apt to forget that the camera is a useful aid in many other branches of field work. In "Exploring Nature with a Camera", Mr. E. G. Neal makes this clear. He deals, it is true, with the photography of birds, but he devotes as much or more space to insect photography, night photography, plant photography and so on. His chapter on night work is illustrated by some good flashlight pictures of badgers near their sett, and we envy him the thrill of taking them. The author says in his preface that "this book is written in the hope that the keen naturalist who has got a camera, especially those of the younger generation, will be encouraged to try it out", and it can be highly recommended as a present for the beginner. Although Mr. Neal says his little volume "is not a technical book on photography", it is full of practical information on the use of the camera (not forgetting his hints on the type of instrument) and how to take pictures of birds, mammals, insects, reptiles, flowers, fungi, etc. Here and there, as if by accident, interesting observations are recorded. Commenting that it is often easier to photograph a portion of an object than the whole, say a few twigs rather than the whole tree, he gives as an instance ice-encased twigs during the great 'crystal thaw' of 1939–40, when trees, bushes and other vegetation were thickly coated with clear ice. Then, as an aside, he remarks, "I was interested to see a wych elm tree with the usual covering of ice, for I knew that the white letter hairstreak butterfly (*Strymon w-album*) laid its eggs every year on the twigs of this particular tree, and that they would now be encased in ice. The following July this species was more common than for many years, so the ice had no appreciable bad effect."

Frances Pitt

Insects of the Pacific World

By C. H. Curran. (Pacific World Series.) Pp. xvi+317+8 plates. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1945.) 15*s.* net.

THIS book is intended as an elementary guide to the insect life on the numerous islands, large and small, of the Pacific Ocean—"from the Galapagos and Hawaii to New Zealand, Sumatra and Burma, and in the area from Australia to Formosa, Japan and the Aleutians". It is a plain, readable account, taking the insects of each order, family by family. Beginning with the true flies, it passes in descending sequence to the Orthoptera and Apterygota. At the end of the book there are brief chapters on the Arachnida and their allies (by W. J. Gertsch), on insects and disease and, finally, instructions on preserving and collecting insects. For the most part the book deals with its subject in very general terms, and says singularly little about individual Pacific insects. Even the well-known elements in the fauna of Hawaii and New Guinea scarcely receive mention. But, as the author remarks, what chance is there to say much about so many insects of which so little is known. The size of the book, indeed, limits the treatment severely. The text-figures and plates are good and, apart from misspellings on pp. 13, 140 and 141, and an erroneous account of *Cactoblastis* on p. 149, the book will aid the beginner who may visit the vast area under consideration. A. D. I.

Esquisse d'une histoire de la biologie

Par Jean Rostand. Pp. 258+14 plates. (Paris: Libr. Gallimard, 1945.) 140 francs.

THIS sketch summarizes the history of biology from the middle of the seventeenth century up to the present day, the term biology being used in a restricted sense to include only the fundamental problems of organic life, namely, the genesis of life; the formation of the organism; and the evolution of species. While the overall treatment of the subject is chronological, its detailed development is traced in relation to the men of science responsible for major advances. The following examples, selected from the twenty-three chapter headings, suffice to indicate the scope and treatment: Redi, Leeuwenhoek and the microscope; the experiments of Lazaro Spallanzani; Cuvier and the science of fossils; Charles Darwin and the origin of species; recent advances in biology. Short biographies of the naturalists who have made major contributions to biological thought are included in the chapters dealing with their work. The book concludes with a table setting out the principal dates in the history of biology, a brief bibliography and an index of names cited. It should serve as a valuable introduction to the subject for university students in biology.

ATOMIC ENERGY AND ITS APPLICATIONS*

By SIR JAMES CHADWICK, F.R.S.

THE fission process can be briefly described as follows. A neutron is captured by a nucleus of uranium 235, forming a nucleus of uranium 236 in a highly excited state. This immediately divides into two fragments of roughly equal mass, and at the same time from one to three neutrons are emitted (and also some γ-radiation). The fragments fly apart with considerable speed and, in their passage through matter, their energy of motion is finally transformed into heat. These fragments are, in general, unstable and may pass through a series of transformations, emitting β-particles and γ-radiations, before they reach a stable configuration.

It was immediately recognized that this discovery was of the greatest significance and that it opened up the possibility of a practical utilization of the enormous store of atomic energy. Not only did the fission of uranium release a large amount of energy, but also the emission of more than one new neutron each time that a nucleus suffered fission suggested the possibility that the reaction could be propagated from atom to atom, developing a whole chain of reactions from one single event. Such a chain process developing in a mass of uranium might take place at an ever-increasing rate and might involve so many atoms that there would be an appreciable, and possibly an overwhelming, liberation of energy. In this way it seemed that a new type of combustion of matter might be possible which would give an energy yield a million times greater than that obtainable by the combustion of the same weight of coal or oil.

A chain reaction will not necessarily develop in any piece of fissile material. Certain conditions must be satisfied. In the first place, the amount of fissile material, or the reacting system as a whole, must be of such a size that there is not too great a chance that the neutrons produced in the fission process can escape and so be unable to carry on the chain. Secondly, the system must not contain more than a limited amount of material which absorbs neutrons, for in this way again the neutrons will be prevented from continuing the chain reaction.

If these conditions are satisfied, the chain reaction will develop and 'run away', unless some special device is introduced to control it. Thus we have two general types of chain reaction—the uncontrolled reaction and the controlled reaction.

Uncontrolled Reaction: the Atomic Bomb

If we wish to use atomic energy as an explosive the reaction must be uncontrolled, for the more rapidly it can proceed, the greater will be the amount of energy set free and the explosive effect.

The question of size is critical for an atomic explosion, for a chain reaction cannot develop if the mass of fissile material is too small. This is because the reaction depends on the conservation of the neutrons produced in the fissions. If the piece of material is too small or of an unsuitable shape, too many neutrons will escape before they hit a nucleus and propagate the reaction. The proportion of neutrons which escape can be reduced by increasing the size of the piece, since the production of neutrons is a volume effect and will therefore increase more rapidly with size than the loss of neutrons by escape, which is a surface effect. Thus a certain minimum amount of material is required, called the critical size or amount, before the reaction can develop so fully that an explosion occurs. If the piece of fissile material is less than the critical size it will be quite stable; but as soon as it exceeds this a chain reaction will develop and multiply itself with enormous rapidity. Thus all that is necessary to detonate a bomb of uranium 235 is to bring together two pieces each less than the critical size but which when in contact exceed it.

Suppose we have succeeded in doing this by some means, and that at the same moment we shoot a neutron into the material. This will cause fission of one uranium nucleus and produce, let us say, two fission neutrons which in turn produce four, and so on in successive generations. Since the fission neutrons have speeds of the order of 10^9 cm. per sec., and since they do not have to travel many centimetres before they produce new fissions, the time between successive generations, in which the number of neutrons is doubled, is of the order of 10^{-8} sec. In a millionth of a second, therefore, the number of neutrons will have increased enormously and a considerable fraction of the mass of U235 will have undergone fission. If only 1 kgm. is used up in this way, the amount of energy released will be as much as from 17,000 tons of T.N.T. This amount of energy is so great that the mass will attain a temperature of many million degrees and a pressure of many million atmospheres. The high temperature causes the emission of an enormous amount of heat and light, and the sudden expansion of the hot gases produces the shock wave of the explosion.

As the material expands, the neutrons can escape more easily and the reaction stops. By this time the hot glowing gases may have expanded to a diameter of about a third of a mile.

In addition to the blast wave and the intense heat and light from the hot gases, the atomic bomb emits an enormous radiation of gamma rays and neutrons at the moment of explosion. Further, the products formed by the fission process are intensely radioactive, and the total amount formed in the explosion may correspond in activity to many tons of radium.

Control of the Chain Reaction

In order to use atomic energy for industrial purposes, it is obviously necessary to control the chain reaction so that the energy can be released continuously and at a predetermined rate. It seems at first sight that the control of a reaction which can develop so rapidly and which can liberate such enormous energies must be exceedingly difficult. This is, fortunately, not the case, and in practice the control is remarkably simple, effective and accurate.

Control depends on the regulation of the neutron flux so that at a predetermined level the flux remains constant, only exactly as many neutrons causing fission in one generation as in the previous generation. The extra neutrons which are produced in the fissions are removed and made unavailable for the reaction. The reaction will then proceed at a constant rate. This balance can be achieved either: (1) by allowing the excess neutrons to escape from the system; or (2) by capturing them in some absorbing medium.

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* From the Melchett Lecture of the Institute of Fuel delivered on October 8. The full lecture is published in the *Journal of the Institute of Fuel*, Dec. 15, 1946.

It will be convenient at this point to define a quantity called the multiplication or reproduction factor. Let us suppose that in a system containing fissile material there is a certain number, P, of free neutrons present at a given time. Some of these neutrons will initiate fissions and thus directly produce new neutrons, Q in number. The ratio Q/P is called the multiplication factor and denoted by k.

If k is less than 1, no chain reaction can develop. Any stray neutrons may produce a fission, but the chain will die away quickly and the system will be perfectly safe. This corresponds to a system which contains less than the critical amount of fissile material.

If k is greater than 1, as in the example quoted above for the atomic bomb, the number of neutrons will increase rapidly from generation to generation and an explosion will occur.

When k is exactly equal to 1, the reaction will proceed at a constant rate and the flux of neutrons will remain constant. This is the condition which has to be achieved for successful application of the chain reaction to general purposes.

The principle of the control of a chain reactor can be illustrated by a simple example. Let us suppose that we have two masses, A and B, of fissile material, each less than the critical amount but together considerably greater than it, and let us consider what happens as A and B are brought closer together.

When A and B are far apart, the leakage of neutrons will be great and the multiplication factor k will be less than 1. Suppose that at some stage in the approach k becomes equal to 0·99 and that we have in the material a source of neutrons which emits 1 neutron per second. This one neutron will produce k neutrons in the first generation, these k will produce k^2, and so on, so that the total number of neutrons being produced per second will be :

$$1 + k + k^2 + k^3 \ldots = \frac{1}{1-k}$$

if k is less than 1.

Thus when $k = 0{\cdot}99$ there will be 100 neutrons produced per second in the material, and the primary source has been multiplied 100 times. As the two parts are brought closer and closer together the leakage of neutrons diminishes, k becomes correspondingly nearer and nearer to 1, and the neutron intensity can be brought to any desired value.

It is evident, however, that an exceedingly fine adjustment of k will be required to reach a high intensity, so fine as to be impossible as a practical operation.

Let us now suppose that the two parts are close enough to make k slightly greater than 1. A divergent chain reaction will now develop and the neutron intensity will rise rapidly, doubling itself in each successive interval of time T given by the formula

$$T = 0{\cdot}7 \, \frac{\tau}{k-1},$$

where τ is the average life-time of one generation of neutrons.

Thus by making k slightly greater than 1 we could raise the level of neutron intensity very rapidly and, having reached the level it is desired to have in our reactor, we could now reduce k to 1 so that the desired level would be maintained.

While this adjustment is simple in principle, the possibility of carrying it out depends very much on the value of τ. Now the fission neutrons are emitted with velocities of the order of 10^9 cm. per sec., so that if they were all emitted instantaneously upon fission the value of τ would be of the order of 10^{-8} sec. But in order to allow time for the adjustment of the mechanisms which control the positions of A and B, we need a doubling time T of the order of a second ; and this would entail an adjustment of the value of k to less than one hundred-millionth part of its value. Even if this could be achieved, there would always be the danger of a slight temperature change or mechanical disturbance which might cause the neutron intensity to rise at an uncontrollable rate and result in a violent explosion.

If the picture I have given were quite accurate, the control of the chain reaction would evidently be a formidable operation. Fortunately, however, not quite all the neutrons are emitted instantaneously upon fission. Some of the fission products transform after a time with the emission of a β-particle into nuclei which are now unstable and emit neutrons.

We have, therefore, in addition to the prompt neutrons released in the fission process itself some neutrons which are delayed after the fission by the time required for the transformation of the fission fragments. The effect of these delayed neutrons is to increase the average time for neutron generation and, therefore, to reduce the rate at which the chain reaction develops.

The importance of this effect can be shown by a simple calculation.

For the purpose of this calculation we may assume that the delayed neutrons form 1 per cent of the total neutron emission from fission and that the average time of delay is 10 sec. We now arrange the assembly of fissile material so that it is only just above the critical condition, with a multiplication factor k greater than 1 but less than 1·01. This means that the prompt neutrons alone will be insufficient to maintain the chain reaction and each generation of neutrons will have to wait for the delayed neutron emission before a divergent increase in intensity can occur. The neutron intensity will double itself for each interval of time T given by

$$T = 0{\cdot}7 \cdot \frac{1-k_p}{k-1} \quad \tau_D,$$

where k_p is the multiplication factor due to the prompt neutrons alone, and τ_D is the average time between the fission and the emission of the delayed neutrons, that is, 10 sec.

If we put $k = 1{\cdot}005$, then k_p will be about 0·995, and the doubling time is about 7 sec.

Thus, provided the assembly is only a small degree above the critical size, the effect of the delayed neutron emission is to make the reaction grow quite slowly. It will therefore be easy to control the reaction and to hold the level of the reaction and the neutron intensity at any desired level. The adjustment of the neutron leakage may be a simple type of mechanical control which moves a small part of the reactor relative to the main system or which moves reflectors which can reflect back into the system some of the neutrons which would otherwise escape. In this way, the reaction can be controlled smoothly and the level of the reaction can be held very steady ; in fact, in some of the so-called 'slow reactors', the level can be held to better than one part in 10,000 over long periods of time.

Fast and Slow Neutron Reactors

The systems I have so far considered are known as fast neutron reactors, because the chain reaction is carried on by the fission neutrons without moderation of their speed except that which inevitably must occur in collisions in the system, whether in the fissile material itself or in parts of the apparatus for assembly, etc., and these neutrons have velocities of the order of 10^9 cm. per sec.

Slow neutrons, however, are much more effective in producing fission both in U235 and in plutonium than are fast neutrons. Thus, if the fission neutrons could be slowed down before reproducing themselves, the chain reaction could be maintained in a smaller amount of fissile material, or even in much less pure material than is required for the fast reactor.

One advantage of the slow neutron reactor is the simplicity of control. Some substances, notably boron and cadmium, absorb slow neutrons very strongly. This fact provides a very ready method of controlling the reaction, by moving rods of these materials in or out of the reactor and so adjusting the multiplication factor by changing the loss of neutrons by absorption rather than by changing the loss by leakage as in the fast reactor. It is obvious that a simple mechanical device will suffice to carry out this control.

A very important advantage offered by the use of slow neutrons is that it is no longer necessary to use pure or nearly pure fissile material in order that the chain reaction should maintain itself. In fact, as is well known, it is possible to use natural uranium, thus avoiding the very expensive and tedious process of separating the isotopes.

In this case, owing to the fact that the 238 isotope captures neutrons without undergoing fission and that this isotope is 139 times as abundant as the fissile 235, the choice of material for slowing down the neutrons is rather limited, for very little additional loss of neutrons can be tolerated. For this reason it has not been found possible to use water as moderator, for hydrogen captures slow neutrons too readily. Heavy water makes a very suitable moderator, for the capture by deuterium is small, and it has been successfully used in the United States and later in Canada. It is, however, too expensive a substance to use for large reactors.

The best material readily available at the present time is carbon, in the form of graphite. This has the advantage of being relatively cheap and abundant, and it can be obtained in a very pure state.

Owing to the inevitable, though small, loss of neutrons by absorption in the graphite, the multiplication factor of a uranium-graphite system is not much greater than 1. The critical size of the reactor is, therefore, rather large, and some tons of uranium and of graphite are required. The construction of a reactor of small power is a straightforward matter, but difficulties arise when large power dissipation is desired, of the order, say, of 100,000 kW., owing to the small latitude in the multiplication factor. The nature of these difficulties will be best illustrated by a brief description of the large reactors, the so-called graphite piles, erected at Hanford, although the primary purpose of these piles was the production of plutonium rather than the generation of power.

Natural Uranium Reactor—the Graphite Pile

For reasons depending on the nuclear properties of uranium, the arrangement which gives the highest multiplication factor is one in which lumps of metallic uranium are disposed at regular intervals throughout a large block of graphite in the form of a lattice. The ideal shape would be spherical, but for practical considerations a rectangular block is used. The optimum size of the uranium lumps and of the lattice spacing can be calculated from the nuclear constants of the materials. This was the arrangement used in the first graphite pile of very low power, but it had to be modified for the plutonium production pile. There were two reasons: first, the uranium has to be cooled in order to remove the heat generated by fission, and it is difficult to concentrate the coolant at small lumps, and second, it was required to remove the uranium without disturbing the assembly of the pile.

The arrangement used in the Hanford piles is, therefore, a rod lattice of cylindrical symmetry, in which short rods or slugs of uranium are loaded in cylindrical channels in the graphite moderator. This entails some reduction in the multiplication factor.

The cooling agent, water in this case, is circulated through pipes around the rods. Since graphite pipes are not practical, on engineering grounds, some other material has to be used, and the choice is limited by the condition that the material must have a small absorption for neutrons. The material chosen was aluminium.

Further, the uranium must be protected from the cooling water, for it is easily oxidized, and even if the slugs were not disintegrated by chemical action, sufficient fission products would enter the cooling water to make operation dangerous. The protective jacket must have a high conductivity in order to transmit heat quickly from the uranium to the water, it must not absorb too many neutrons, and it must not corrode. Aluminium fulfils these conditions fairly well.

The introduction of this auxiliary material in the form of cooling pipes, sheathing, instruments, etc., increases the loss of neutrons by absorption, and it is, therefore, necessary to keep down the loss by leakage to a few per cent. This is not difficult, for the leakage can obviously be made as small as desired by making the reacting system sufficiently large.

The problem of dissipating some 100,000 kW. or so is not difficult provided an ample supply of pure water is available, but it is complicated by factors peculiar to an atomic energy reactor. In its passage through the pile, the water becomes radioactive, so that if the water is to be returned to a river a retention basin must be provided to ensure a delay, during which the induced radioactivity dies down to a safe level. Further, the circulating system must be very reliable, and fast-operating controls must be provided in order to shut down the chain reaction quickly in case of failure of the water supply.

The control is essentially no more difficult than for a small slow reactor, but, of course, the large reactor is potentially much more dangerous. The operating controls, connected with instruments in the pile, which measure the neutron density and thus the power level, can automatically keep the pile operating at a predetermined level. In addition, emergency controls are provided to operate as soon as the power level shows signs of undue increase.

The radiation from a pile operating even at low power is strong enough to be dangerous to human life, and that from a high-power pile reaches a fantastic intensity. The whole of the reacting unit must, therefore, be enclosed in steel and thick walls of concrete, and it must be possible to load and unload the pile through these shields. Any operation on the pile must be carried out by remote control.

The design and operation of the Hanford piles was thus beset by difficulties, many of them new and peculiar to an atomic energy plant, but they have operated for nearly two years without trouble at a power level of perhaps a few hundred thousand kilowatts.

The total weight of a pile, including the massive shielding, amounts to some thousands of tons, but it is, nevertheless, a very compact unit for the amount of power which is generated in it.

Production of Useful Power

The energy generated in the Hanford piles is removed by the cooling water which issues at a temperature considerably below 100° C.—too low a temperature for efficient conversion of the heat to useful power. If such a pile is to have general industrial applications, such as the generation of steam and the generation of electric power, it must be run at a much higher temperature. To do this will necessitate considerable changes in design and in operating technique.

It would probably be possible to use liquid bismuth as coolant instead of water, and it might be an advantage to use some other material than graphite as moderator. Progress on these lines demands the solution of some awkward engineering and metallurgical problems; but there is no reason to suppose that the difficulties cannot be overcome.

The most striking characteristics of atomic energy reactors are their compactness for large power capacity and their ability to run for long periods with little or no refuelling.

The power available from an atomic energy reactor is limited essentially only by the rate at which the heat can be removed from it, so that a million-kW. plant need be no bigger than a normal electric power sub-station.

The energy released in the combustion by fission of 1 lb. of U235 or plutonium is rather more than 11 million kWh., equal to the amount of energy which can be obtained from about 1,500 tons of coal or 250,000 gallons of fuel oil. Thus an atomic energy unit may be able to run for long periods on one charge of fuel, and the cost of transport of fuel will, in any event, be small.

Moreover, the plant may, under appropriate conditions, be able to regenerate some, if not all, of its fuel. This arises from the possibility of designing the plant so that some of the neutrons released in fission are used to produce plutonium in uranium, disposed in a suitable way inside or outside the reactor, which will replace the U235 or plutonium which is burned.

This process of replacement takes place in the Hanford piles, where U235 is indirectly converted into plutonium. It may be possible under some conditions to arrange that as uranium 235 is burned the reaction could continue by burning the plutonium, and in this way most of the uranium 238 as well as the 235 might be utilized.

This relative freedom from supply problems, once the plant is set up, opens up the possibility of stimulating industrial development in isolated parts of the world, where coal- or water-power are not readily available. For the same reason, it might prove advantageous to establish atomic energy units in close proximity to mines, more especially in those cases where the ores have to be transported long distances in their crude states.

They may also find application in large ocean-going vessels, in cases where it is desired to avoid frequent refuelling. This application is somewhat more questionable on account of some aspects of atomic reactors, to which I shall refer later.

We must not forget, however, that these bright prospects for the peaceful applications of atomic energy depend on the solution of difficult engineering problems, and that no reactor has yet been developed, or, I believe, even designed, which is suitable for the purposes I have mentioned. Nor must we forget the limitations and disadvantages to which the atomic energy unit is subject, and which are inherent to it.

One of the most serious disadvantages from the point of view of general industrial use arises from the fact that an atomic energy reactor is a source of very intense and very dangerous radiations. A reactor operating at a power level of 1 watt produces as many γ-rays as a few grams of radium (without the radiations from the fission products) and some neutron radiation as well. Although a considerable fraction of these radiations will be absorbed in the reactor itself, shielding is required in order to protect personnel in the vicinity. Even in the case of a very compact unit, the weight of shielding will be considerable.

For example, let us take the case of a reactor dissipating (not generating as useful energy) 100,000 kW. This cannot be much less in size than a 1-metre cube, having regard to the difficulty of the problems of heat transfer. It is easy to show that the weight of the shielding required to reduce the radiations from this unit to a safe level would be a few hundred tons. Even a low-power reactor will need shielding at least 50 to 100 tons in weight, and this factor alone prohibits the application of this type of power to motor-cars or any small mobile units.

Another limitation in the application of atomic energy is that a relatively large amount of fissile material is required even for a low-power unit. This arises from the fact that a 'critical size' is necessary before the chain reaction can develop. Thus, for some time to come, the minimum cost of materials for a power unit may be many thousands of pounds, and it becomes uneconomic to use atomic energy for small plants.

Another consideration is that practically every material which is incorporated in the construction of an atomic reactor becomes radioactive owing to its exposure to neutrons. For this reason, special provisions would have to be devised for maintenance.

The intense γ- and neutron-radiations also have an effect on the structural properties of the materials entering into the construction of the reactor. Owing to their ionizing properties, these radiations destroy the molecular bonds of many molecules. The choice of substances which can be used is, therefore, restricted to those which tend to return to their original state after intense ionization, such substances as elements and simple ionic compounds. How far even these will endure the very great irradiations resulting from large power outputs is not known, for experience is still very meagre. This effect may possibly set a limit to the power output of an atomic reactor and even to its life.

A further difficulty may be caused by the fission products, more especially in the case of the natural uranium reactor. Some of these fission products may absorb neutrons so strongly that after some time the chain reaction will be inhibited. In such a case, it would be necessary to remove the uranium, extract the fission products, and either to recharge the reactor with new metal or to recover the uranium and to replace it, adding sufficient plutonium or U235 to make it reactive.

Of necessity, all reactors manufacture fission products. At some stage or other, it will ultimately be desirable to remove them. Their disposal may prove to be an awkward problem.

Cost of Power Derived from Atomic Energy

So far as the *immediate* future is concerned, the application of atomic energy to the production of power is not likely to result in a net decrease of over-all costs to the community.

Owing to the difficult and tedious nature of the processes for preparing U235 or plutonium in high concentration, reactors depending on such materials for fuel will be far more costly to run than existing hydro-electric or steam-power plants, and the most favourable comparison at the present time will be given by the natural uranium reactor.

Recently an American committee has made a careful study of the costs of building and operating a natural uranium reactor to deliver 75,000 kW., and has concluded that the over-all cost of power would be only about 25 per cent greater than for a coal-burning power plant. This estimate is based on the assumption of a high operating temperature of the uranium reactor, that is, on the performance of a plant which has not even been designed, let alone built. It does not, therefore, represent the present position, but the possible position in a few years time, when research and development have provided the solution of a number of difficult technical problems. The committee's estimate is nevertheless valuable in indicating the possibilities which can already be foreseen. It is not unreasonable to expect that future development of atomic energy will result in a material reduction of costs, and perhaps make the uranium reactor a direct competitor with other power plants.

At the present moment it seems that the use of atomic power plants would be justified, on a purely economic basis, only in the special circumstances I have previously mentioned, where the power needed to develop resources is either very costly or unavailable, or because of difficulties of transport.

What is needed now is intensive research and development in the technical problems which are involved in the applications of atomic energy. This will not only clarify our present somewhat vague ideas, but it may well be that quite new lines may be opened up.

The Future

In assessing the possibilities of future development it is well to remember not only that the art is in its infancy, but also that the preoccupation of the war years with the military aspects of atomic energy has excluded almost completely the consideration of industrial applications. These military aspects still have, and, until some far-reaching international agreement on the control of such weapons is obtained, are bound to have, a retarding influence on peaceful developments, for the reason that the paramount need for security prevents that wide dissemination of knowledge which promotes free exchange of thought, stimulates discovery, and gives an impetus to invention and development.

At this early stage in our knowledge of these matters one cannot hope to see clearly into the future, but only to discern the probable lines of progress. Upon further investigation some lines we now have in mind may prove fruitless, but if we can be guided by the history of scientific and technical development, it is more than likely that others will give a rich reward. A few short years ago what has even now been accomplished would have been considered an idle dream.

Already a military weapon of unparalleled power has been created; enormous amounts of radioactive material have been manufactured; substances which have, owing to their inherent instability, become very rare or even completely disappeared from the cupboard of Nature, have been built up by individual nuclear transmutations and collected in large quantities; and the first steps have been taken towards the development of these new energy sources for industrial application.

This new enterprise constitutes a far deeper interference with the natural course of events than anything which has been attempted hitherto, and it is a most remarkable example of the powers of physical science and engineering and of our increasing control over the processes of Nature. It is not easy at this early stage to survey in detail the consequences which may flow from this advance in the years to come, but it can scarcely fail in the long run to bring about a new outlook and a new situation as regards human resources.

DR. JAMES HUTTON AND THE MANUFACTURE OF SAL AMMONIAC

By ARCHIBALD CLOW and NAN L. CLOW

THE hundred and fiftieth anniversary of the death of Dr. James Hutton (1726–97), the celebrated geologist, which occurred on March 26, brings to mind a little-known phase in the utilization of the products of coal distillation, the profits from which are said to have secured to Hutton the leisure necessary for his geological speculations.

In his "History of Inventions and Discoveries", J. Beckmann says: "If I am not mistaken, the first manufactories of sal ammoniac were established in Scotland: the oldest of these, perhaps, was that erected by Dovin and Hutton at Edinburgh in 1756"[1].

This refers to a co-partnership formed by Dr. James Hutton and someone variously described as James Dovin, Dairy, or Davie, in Edinburgh according to a plan conceived when they were Edinburgh students. In Kay's "Portraits"[2], the date of formation is given as before 1749, which may be right, since Hutton went to a Norfolk farm to study agricultural methods in 1752.

The raw material used in this early chemical manufacture was soot, and for a number of years Davie took all the soot collected by Edinburgh 'tronmen'—a chimney sweeps' society formed in 1738[3]. The process was carried out as follows: "Globular glass vessels, about a foot in diameter, are filled to within a few inches of their mouth with it [soot], and are then arranged in an oblong furnace, where they are exposed to a heat gradually increased. The upper part of the glass balloon stands out of the furnace, and is kept relatively cool by the air. On cooling, the upper parts of the globes are found to be lined with sal ammoniac in hemispherical lumps, about 2·5 inches thick. 26 lbs. of soot yield 6 of sal ammoniac."

There is a reference to the manufacture of sal ammoniac in Edinburgh, and to green glass globes used in the manufacture, in a letter from John Findlay, secretary to the Duke of Richmond, to George Macintosh, the Cudbear and Turkey red manufacturer, and it seems probable that the vessels used by Hutton and Davie were old vitriol bottles from the Prestonpans Vitriol Works, founded by Dr. John Roebuck and Samuel Garbett in 1749[4].

The firm of Hutton and Davie was still in existence in 1783, and in that year they began buying sal ammoniac, probably crude, from the tar works established at Culross in 1781 by Archibald Cochrane, ninth Earl of Dundonald.

Dundonald's sal ammoniac was one of the by-products of his tar manufactory. The preliminaries in the negotiations for the sale of the sal ammoniac to Hutton and Davie are referred to in the report that Dr. Joseph Black, professor of chemistry in Edinburgh, prepared for Andrew Stuart, when the latter was trying to ascertain the likely success that might attend the founding of the British Tar Co. After going into the details of prospective profits from the sale of tar and coke, Dr. Black goes on : "There is one article omitted above, which is a quantity of Volatile Alkali formed in the water condensed along with the tar from the vapour of the coals. The volatile alkali, after being somewhat refined from the oil and water can be employed in the manufacture of sal ammoniac : and My Lord having sent a specimen of his prepared or purified alkali to Messrs. Hutton and Davie who manufacture sal ammoniac here, I know that they found it good for the purpose and made his Lordship an offer for a certain quantity annually, the consumption of sal ammoniac being limited. But I do not know what offer they have made, or what profit this article is capable of yielding. They have hitherto extracted their volatile alkali from soot, which is also produced by the condensation of vapour from coals"[5].

Evidently Lord Dundonald hoped to make a considerable business by working up this side-line, because he wrote Andrew Stuart, his uncle : "My partners and I have it in our Power to render him [Glassford]* very essential service by purchasing from him annually some Thousand Pounds worth of a commodity he manufactures concerning which I shall explain myself more fully when I have the pleasure of seeing him in Scotland"[6].

The latter refers to the purchase of either sulphuric acid or hydrochloric acid, to be used in the manufacture of sal ammoniac.

Dundonald sent a William Kinnaird, chemist and apothecary, to London in 1784 to learn the best way of making sal ammoniac. Dundonald and his two brothers, John and Alexander, who were already his business associates in the British Tar Co., were to join Kinnaird in the manufacture ; but difficulties arose over Kinnaird's wages, and it is said that he did everything he could to sabotage Dundonald's enterprise because he wished to start on his own[7].

The method of manufacture employed by Dundonald was probably that invented by M. Leblanc of St. Denis, near Paris, with this difference, that Leblanc got his ammonia by the destructive distillation of organic matter, whereas Dundonald's ammonia was produced by the action of heat upon nitrogenous matter in coal. The ammonia was combined with hydrochloric acid, which was produced in a brick kiln by the action of sulphuric acid on the sea salt he could obtain from his own pans at Culross[8].

None the less, soot continued to be used as a raw material, both by Hutton and Davie, and also in a new manufactory which was founded by Charles Macintosh at Glasgow in 1786, in partnership with his father, George Macintosh, of the Cudbear and Turkey Red Works, and a Mr. William Couper, an eminent Glasgow surgeon.

The Macintosh factory continued for a number of years, but it is probable that more scientific methods of making sal ammoniac led to its being closed down[9]. In any event, by 1814, according to Sir John Sinclair, there was only one sal ammoniac works of any size in Scotland, and that was at Bo'ness[10]. There Joseph Astley operated a patent process similar to that referred to in the *Annales de Chimie* of 1797 (20, 186), which used 'bittern' from the salt works as a raw material. From this factory sal ammoniac was retailed at £9 10*s.* 10*d.* per cwt. Considerable details about Astley's process are given by Thomas Thomson in his supplement to the "Encyclopædia Britannica" :

"One process more deserves to be mentioned, on account of its ingenuity and simplicity. It is the invention of Mr. Astley, who has secured the exclusive privilege by a patent, and has a manufactory at Borrowstowness, on the Firth of Forth, and another at Portobello, near Edinburgh. He mixes together animal matter (chiefly woollen rags), and what in Scotland is called *spirit of salt.* It is the mother ley that remains after all the crystals of common salt that can be got have been separated from sea-water. It consists chiefly of muriate of magnesia. This mixture is burned in furnaces, and the produce received in small chambers placed over the furnaces. This produce contains abundance of sal ammoniac, which is obtained pure by sublimation. We conceive the theory of this process to be, that the carbonate of ammonia is formed by the combustion of the animal matter. This carbonate immediately decomposes the muriate of magnesia, and sal ammoniac sublimes. In principle, therefore, it does not differ from Baume's original process, though, in point of economy, it is probably greatly superior to it."

Hutton died in 1797, and Davie not long after. Following Davie's death, it appears that Edinburgh soot was sent to Walker's works at Beverley, Yorks, because we learn that Astley, who is described as an extensive chemical manufacturer in Portobello, was involved in a legal action in the Court of Session through one of his clerks inveigling two or three members of the Edinburgh Tronman's Society (chimney sweeps) into a public house and persuading them to sign an agreement on behalf of the Society to supply Astley with all the soot they collected instead of sending it to Yorkshire[11].

The next phase in the utilization of coal by-products is the well-known development of the gas industry in the first two decades of the nineteenth century. The new information which we have set forth concerning the prior utilization of coal by-products throws new light on the economic background of the gas industry. It also gives a new perspective to the growth of experimental chemistry during the latter half of the eighteenth century; and it is worth bearing in mind that when Joseph Priestley discovered ammonia, he was exploring the properties of a substance of established utility as a saleable by-product of coal.

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* Glassford of Dougaldston, a principal partner in the Prestonpans Vitriol Co.

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[6] Lord Dundonald to Andrew Stuart, Edinburgh, December 11, 1782 (N.L.S.).

[7] Session Papers, 380, 37 (S.L.).

[8] Ure, Andrew, "A Dictionary of Chemistry", Art. Ammonia, *Ann. de Chimie*, 19, 61 (1797). Parkes, S., "Chemical Essays", 4, 339–395 (London, 1815).

[9] Macintosh, G., *op. cit.*

[10] Sinclair, Sir J., General Report, App. Vol. 2, 310.

[11] Session Papers, 282, 14 (S.L.).

NATURE OF VIRULENCE

THE term 'virulence' has sometimes in the past been regarded as an intrinsic property of an infecting agent; that such a view is not entirely in accord with our knowledge of natural and experimental infections was apparent from the discussion on the nature of virulence at the meeting of the Society for Microbiology held in London on December 20. As virulence can only be measured in terms of the effect on the host by a micro-organism, using that term in its widest sense, it is obvious that the interaction between the micro-organism and host by which we estimate virulence will depend on many variables affecting both participants. Much of the discussion related to these variables and their effect on virulence. A very wide field was covered, contributions on the virulence of bacteria, of fungi and of viruses for both plant and animal hosts and of the parasitic protozoa being made by various speakers. It was generally accepted that multiplication of an infecting agent in the body of the host does not alone determine virulence, and that the term 'virulence' necessarily implies structural or functional damage to the tissues of the host.

It is clear that the morphology and physiology of plants are so different from those of animals that virulence of phytopathogens involves mechanisms different from those concerned in virulence of micro-organisms for animals. This point was clearly illustrated by Mrs. Dagny Oxford in her discussion of bacterial virulence in plants; the bacteria virulent for plants, unlike most of the animal pathogens, are free-living, relatively resistant and simple in their nutritive requirements. As most of these species do not split cellulose, they depend for their entry into plant tissues on abrasions or wounds. There may be some correlation of virulence of phytopathogenic bacteria with the power to produce pectolytic enzymes, and in some instances cell-free filtrates of bacterial cultures produce reactions in the plant tissues similar to those caused by the living bacteria. Mrs. Oxford pointed out that the resistance of plants to bacterial infection is a function of the local tissue cells and does not depend on any humoral mechanism such as operates in the resistance of animals to invading bacteria.

Fungi are, however, more important disease-producing agents in plants than are bacteria, and Prof. E. Gäumann of Zurich made a most interesting contribution in this field to the symposium. The necessary attributes for virulence were discussed in relation to different types of pathogenic fungi, the part played by the host tissues being emphasized. The damage to plant tissue appears in the case of one fungus to be due to a polypeptide which destroys the semipermeability of the plasma boundary layer; but the power to produce this substance *in vitro* is not of itself sufficient to determine virulence. The power to penetrate the plant tissues by the production of certain enzymes and to withstand the reactions of the host tissues are also necessary. In plant infections due to more than one fungus (mixed infections), the resulting disease may be dependent on the interaction of the infecting fungi and may not be controlled by the most virulent strain.

In his discussion on the virulence of bacteria in animals, Dr. D. W. Henderson pointed out that it is difficult to induce parasitism in normally saprophytic bacteria, and that this lack of virulence is due in some instances, although perhaps not in all, to their lack of power to multiply in the living body. In general, toxicity is inversely proportional to the degree of tissue invasion by a pathogenic bacterium. The species of the animal host, its physiological state, and its genetic constitution may all influence the virulence of a bacterial infection. Other points mentioned by Dr. Henderson as bearing on virulence concerned aggressins, route of entry of a bacterium into the body, and the synergistic action of other bacteria. The importance of the last two factors was later referred to by Dr. C. H. Andrewes in relation to the virulence of viruses for animals.

That apparent increase of virulence in a parasitic micro-organism may in fact be due to lessened resistance of the host was exemplified by Dr. J. T. Duncan in his contribution on virulence of ringworm fungi in animals. These fungi are frequently highly parasitic and highly infectious but of low pathogenicity, and the host parasite equilibrium may remain undisturbed for years. On the other hand, some of the normally saprophytic fungi may become highly pathogenic, producing severe systemic disease; and in some of these fungi pathogenicity is associated with the property of dimorphism, the organism being capable of developing, in place of the complex mycelial saprophytic form, a simple form adapted for rapid reproduction and invasion in animal tissues. In the case of such fungi, as with some of the ringworm fungi when implanted on an unusual animal host, high pathogenicity may be associated with low infectivity.

The parasitic protozoa afford instructive examples of variations in the host parasite relationship in relation to virulence. Prof. H. E. Shortt illustrated the state of true symbiosis between certain protozoa and their vertebrate or invertebrate hosts, and from the symbionts and commensals went on to consider the parasitic protozoa. Some of these may multiply without producing disease, but this balanced parasitism might be readily upset. The mechanism by which disease is produced by pathogenic protozoa is not clearly understood; no true toxins are demonstrable, and in some cases disease is due to mechanical effects resulting from extreme proliferation of the parasites in particular cells or tissues; for example, certain trypanosomes in the reticulo-endothelial cells or muscle, and the malaria parasite in blood cells. Death of such highly parasitized hosts is frequently due to super-added infection with bacteria or other infecting agents. In the state of latent or chronic protozoal infection, it can be shown by transfer to fresh hosts, or by measures which lower the resistance of the chronically infected animal, that the protozoan has not lost its virulence. On the whole, it seems that for this class of micro-organism (as for the viruses and certain of the more parasitic bacteria) excessive virulence is a disadvantage to the parasite from the point of view of survival of the species, and virulence may represent the initial stages of association between the parasite and host, to be succeeded by commensalism or symbiosis.

The virulence of viruses for plants or animals must be considered only as a virus-host relationship, as the known viruses are essentially parasitic. Both Dr. Kenneth Smith and Dr. C. H. Andrewes stressed the variations in virulence manifested in virus-host associations according to variations artificially induced or arising naturally in the infecting virus, or depending on host factors and particularly on host species. The highly virulent virus which always produced death of the tissues or whole plant would, as Dr. Smith pointed out, have difficulty in transmission to fresh hosts and thereby in ensuring survival. Such plant viruses, however, while apparently possessing intrinsic virulence for one plant, usually infect other plant hosts without producing symptoms. Variations in virulence can be produced by various procedures which probably favour selectively the multiplication of a virulent variant already present in the virus strain. The emergence of virus mutants under laboratory conditions was also mentioned by Dr. Andrewes, who suggested that the selective survival of mutants showing antigenic variations from the original virus may explain the course of certain human epidemic diseases. From several viruses stable variants can be produced by adaptation to a new host species. The highly virulent virus is able to multiply extensively in invaded host cells, and to destroy these cells with liberation of virus for the attack on further cells. Although the mechanism responsible for cell destruction is not known, recent work with rickettsiæ and influenza virus suggests that these agents in the living state, if present in sufficient concentration, can exert a toxin-like action. Virulence of the animal viruses may also depend upon special tissue affinities, as in the neurotropic viruses. The adaptation of virus to host which results in latent infection may, as in other host-parasite associations, be readily upset.

Prof. A. W. Downie, in summing up the discussion, referred to various points made by previous speakers and suggested that the host-parasite relationship studied under experimental conditions might not show the manifestations of virulence which are evident under field conditions as shown by the behaviour of epidemic disease. We are ignorant of the mechanism by which damage to the tissues of the infected host is produced, and in this field there seems much to be done in the study of the biochemical interactions of parasitic micro-organisms or their enzymes and toxins with the metabolic processes of the host cells.

OBITUARIES

Prof. Robert Newstead, F.R.S.

Robert Newstead was justly proud of the fact that the high place which he achieved for himself in the scientific world, and the distinction which he brought to the Liverpool School of Tropical Medicine and to his adopted city of Chester, were won by him in face of almost insuperable obstacles, associated with an interrupted schooling and an absence of university training or contacts, until he was more than forty years of age.

Newstead, whose death occurred on February 16, was born on September 11, 1859, at Swanton Abbott, Norfolk, and received his early education at a village elementary school, from which he not infrequently played truant in order to be out in the fields and the woods, watching bird- and animal-life. At the age of ten he left school and was apprenticed to the village post and telegraph office, which included also a printer's and stationer's works. There, during the period of the Franco-Prussian War, Newstead became familiar with the processes of printing and studied telegraphy, in which he passed one examination. From telegraphy he passed to gardening and a little farming, devoting his spare time to the study of a small text-book of zoology, from which he taught himself the elements of systematic study, and to the collection of specimens of plant-, animal- and bird-life. One such collection, made primarily for his own pleasure, led to the beginning of his long connexion with Chester. In 1883, at the age of twenty-four, he was invited to exhibit a collection of Norfolk insects, birds and fungi at the Town Hall, Chester. His specimens attracted the attention of the late Mr. Alfred Walker, a disciple of Charles Kingsley and an ardent naturalist, who straightway offered him an appointment in his gardens, partly as gardener, partly as naturalist.

While holding this appointment, Newstead was present at the laying of the foundation stone of the Grosvenor Museum, Chester, and in 1886, when the Museum was opened, he realized one of his early ambitions by being appointed its first curator. The curatorship of the Museum was held for nineteen years, during which time Newstead was responsible for arranging and describing the exhibits in the natural history and archæological sections, both of which were enriched by many specimens which he personally prepared and mounted, not only during his tenure of office, but also long after his retirement; and I have seen him busy with this work after he had passed the age of eighty-five.

In 1906 Newstead was appointed lecturer in economic entomology and parasitology at the Liverpool School of Tropical Medicine, six years after its foundation as the first school of tropical medicine in the world, and at a time when it numbered on its staff such eminent men as Sir Ronald Ross and Sir Rubert Boyce. The importance of Newstead's work now began to receive wider recognition; in 1908 he received the degree of master of science *ex officio* in recognition of his scientific achievements, and in 1911 he was elected first holder of the Dutton Memorial chair of entomology in the University of Liverpool. From that time until his retirement from the chair in 1924, Newstead held a leading place in the world of entomological research. He was dispatched on two scientific expeditions organised by the Liverpool School of Tropical Medicine: first, to

Jamaica in 1908, to make investigations into the causes of the prevalence of sarcoptic mange among cattle; and secondly, to Malta in 1910, to study the bionomics of sandflies. In 1911 he worked on the Royal Society's Sleeping Sickness Commission in Nyasaland, where he spent five months in the bush investigating the breeding-places and habits of the tsetse fly; and during 1913–14 he was a member of the inter-departmental committee on the same disease. During the First World War he was engaged by the War Office to take charge of the Entomological Commission appointed to investigate methods for the control of fly-borne diseases occurring in the camps of France and Flanders, and directed the Liverpool centre of investigation set up by the Royal Society Grain (Pests) War Commission, 1916–20, to deal with the damage caused to grain by insects and mites during transit and in store. He was elected a fellow of the Royal Society in 1912.

Entomology, however, was not the only subject upon which Prof. Newstead was an authority. His appointment as curator to the Chester Museum marked the beginning of his interest in the study of the Roman occupation of Chester. So early as 1899 he was writing on Roman remains which had recently come to light in Chester and Penmaenmawr. In 1914 he began active digging, and from that time onwards, until a few months before his death, he took a large part in excavating, preserving and describing Chester's Roman antiquities. These discoveries and the resultant additions to our knowledge of the Roman occupation were fittingly recognized by the citizens of Chester in 1936, when they conferred upon him the honorary freedom of the city.

During his life-time, Newstead published more than two hundred papers and, since he was an artist of considerable ability, many of them were illustrated by his own hand. As might be expected from such a long, diligent and far-seeking career, these papers covered a wide range of entomological and archæological subjects; but essentially Newstead was a biologist of the old school, a trained observer of Nature, and one who was at his best and happiest in the open air.

We regret to announce the following deaths:

Sir Joseph Barcroft, C.B.E., F.R.S., emeritus professor of physiology in the University of Cambridge, on March 21, aged seventy-four.

Prof. Pierre Janet, well known for his work on psycho-pathology, on February 24, aged eighty-seven.

NEW FELLOWS OF THE ROYAL SOCIETY

At the meeting of the Royal Society on March 20, the following were elected fellows:

Dr. W. J. Arkell, formerly senior research fellow of New College, Oxford, distinguished for his researches on the stratigraphy and palæontology of the Jurassic system; he is the author of valuable palæontological monographs on the Lamellibranchs and Ammonites of the British Corallian.

Dr. G. M. Bennett, Government Chemist, distinguished for his work in organic chemistry on the reactivity and configuration of organic molecules.

W. S. Bisat, civil engineer, Collingham, near Leeds, distinguished for his studies in Carboniferous stratigraphy and palæontology; his methods have been successfully applied in Europe and North America.

Mary Lucy Cartwright, fellow of Girton College and lecturer in mathematics in the University of Cambridge; distinguished for her researches in the theory of functions of a complex variable.

Prof. E. J. Conway, professor of biochemistry, University College, Dublin, distinguished for his work on chemical and physico-chemical processes in living tissues.

Prof. T. G. Cowling, professor of mathematics in the University College of North Wales, Bangor, distinguished for his mathematical contributions to astronomy, the theory of gases, the physics of the ionosphere, and geomagnetism.

J. Craigie, member of the scientific staff of the Imperial Cancer Research Fund, London, distinguished for his work in bacteriology and immunology, and especially for his studies of viruses.

M. B. Crane, head of the Pomology Department of the John Innes Horticultural Institution, London, a notable breeder of new varieties of horticultural plants, whose researches have elucidated the genetical constitution and origin of cultivated English fruit trees and unravelled many problems relating to pollination and the setting of fruit.

Prof. W. J. Duncan, professor of aerodynamics at the College of Aeronautics, Cranfield, distinguished for his contributions to an understanding of flutter in aircraft, and of related problems of elasticity and vibrations.

Prof. M. G. Evans, professor of physical chemistry and head of the Department of Chemistry, University of Leeds, distinguished for his contribution to chemical kinetics and especially for his theoretical work on the modern concepts of reaction velocities.

Dr. W. S. Feldberg, lecturer in physiology, University of Cambridge, distinguished for researches on the mechanism of the humoral transmission of excitation, particularly in relation to the phenomena in which acetylcholine is concerned.

T. Goodey, principal research officer, Institute of Agricultural Parasitology, St. Albans, distinguished for his work on the structure, life-histories and economic importance of nematode worms, particularly those parasitic on plants.

Dorothy Crowfoot Hodgkin, fellow and tutor of Somerville College, Oxford, and University demonstrator in chemical crystallography, distinguished for a long series of investigations by X-ray crystal analysis into the structure of the sterols, proteins and other complex organic molecules.

J. Hutchinson, keeper of the museums, Royal Botanic Gardens, Kew, distinguished for his researches on the taxonomy and affinities of flowering plants and his contributions to the study of the flora of Africa.

Dr. D. A. Jackson, lecturer in spectroscopy, University of Oxford, distinguished for his method for separating close spectral lines and measuring their wave-lengths; by this means he was the first to determine magnetic and mechanical moments of various atomic nuclei.

Prof. G. Jefferson, professor of neurosurgery in the University of Manchester, distinguished for the leading part he has played in the development of the surgery of the brain and spinal cord, in the treatment of head injuries, and for his studies of the physiological disorders resulting from brain injury.

Prof. H. A. Krebs, professor of biochemistry, University of Sheffield, distinguished for his work on intermediary reactions in cell metabolism.

Dr. F. G. Mann, reader in organic chemistry and fellow of Trinity College, Cambridge, distinguished for his work on stereochemistry with particular reference to complex metallic salts and derivatives of arsenic, phosphorus and antimony.

Prof. P. B. Moon, professor of physics, University of Birmingham, distinguished for his researches in atomic physics and for his contributions to the development of micro-wave radar and to the subject of atomic energy.

Dr. E. Orowan, Cavendish Laboratory, Cambridge, distinguished for his fundamental contributions to the physics of metals; his work on plastic deformation, fracture and fatigue is characterized by particular originality and elegance.

Prof. F. A. Paneth, professor of chemistry, University of Durham, distinguished for his pioneering researches in radio-chemistry and for the discovery of free organic radicles of short life; he has undertaken chemical and radio-chemical work in connexion with atomic energy.

Muriel Robertson, head of the Department of Protozoology of the Lister Institute, London, distinguished for researches on the life-cycles of Protozoa and on immunology.

Prof. F. J. M. Stratton, professor of astrophysics, University of Cambridge, fellow of Gonville and Caius College, and general secretary, International Council of Scientific Unions, distinguished for his researches on novæ, and for his part in planning and organising work for the observation of eclipses.

Prof. C. H. Waddington, professor of animal genetics, University of Edinburgh; chief geneticist of the Animal Breeding Research Organisation (Agricultural Research Council); distinguished for his work on experimental embryology and its relation to genetics.

Air Commodore F. Whittle, adviser (engines) to the Controller of Supplies (Aircraft), Ministry of Supply, distinguished for his work on jet propulsion.

NEWS and VIEWS

Coal Gas and Fuel Industries at the University of Leeds: Prof. A. L. Roberts

In 1910 the gas industry endowed the Livesey chair at the University of Leeds to perpetuate the memory of Sir George Livesey, the eminent engineer of the South Metropolitan Gas Company. It was first held by W. A. Bone, who was followed by J. W. Cobb in 1912, and by D. T. A. Townend in 1938. When in 1945 the University granted Prof. Townend leave of absence to take charge of the British Coal Utilisation Research Association (*Nature*, **155**, 783; 1945), Dr. A. L. Roberts, senior lecturer in refractory materials, was appointed acting head, and he has now been appointed to the chair.

Educated at Christ's Hospital, Horsham, Prof. Roberts held an Ackroyd Scholarship at Leeds, and afterwards undertook research under the direction of Prof. R. Whytlaw-Gray into the redetermination of the atomic weight of silicon. In 1930 he was appointed demonstrator in refractory materials in the Department of Coal Gas and Fuel Industries, in succession to Dr. (now Sir) Hubert Houldsworth, a field in which, after collaborative research with Prof. Cobb, he rapidly became eminent. In recent years Prof. Roberts has taken a leading part in the research associated with the gas industry, under the Joint Research Committee of the University of Leeds and the Gas Research Board, for which the University is renowned, specializing in the newer applications of radiant heat to drying, etc., processes. He has also collaborated with the Yorkshire Industrial Gas Development Centre in the development of the permeable lining principle in furnace practice, and with the British Refractories Research Association in an investigation into long-dated effects which occur in siliceous refractories used in carbonizing plant. In another field he has studied the influence of constituent minerals on the working properties of refractory materials, revealing a new species of kaolinitic mineral in plastic fireclays; and during the Second World War he undertook Government work upon the fundamentals of recrystallization of highly refractory materials, an important research since then supported by the Department of Scientific and Industrial Research, and having wide applications, including that in gas turbines, etc. In this connexion he visited Germany in 1945, and has served on a number of Government committees. He has been closely associated with the recent developments in chemical engineering in the University of Leeds, and is a leading figure in local sections of several professional bodies in the Yorkshire area.

Meteorological Stations in the Arctic

The Canadian Government, in close association with the Government of the United States, is planning the establishment of nine meteorological stations in the Arctic. The project will probably take several years to complete, because of the limited period each year during which the sea north of the Arctic Circle is navigable. It is intended that the stations, once established, will be supplied by air. Meteorologists have long felt the need for an increase in the number of stations making regular weather reports in the Arctic regions of the North American continent. The principal requirement is not just for short-lived series of surface observations such as are obtained from expeditions, but rather for the operation of fixed stations making *radio-sonde* measurements of pressure, temperature, humidity and wind over a period of years. The Canadian scheme is therefore expected to provide data of vital importance to general studies on atmospheric circulation and in particular to weather forecasting. This development is of special interest to aviation owing to the increased attention that is being given to the possibilities of inter-continental flying by great circle routes passing over the Polar regions. It is understood that the U.S.S.R. are also anxious to increase the number of meteorological stations in their territory within the Arctic Circle. For this purpose, attempts are being made to develop an automatic weather reporting station that would measure and transmit the values of meteorological elements at regular intervals over a long period.

Ice Accretion on Aircraft

An interesting series of experiments on the Vickers "Viking" airliner by the British European Airways Corporation in conjunction with Messrs. Vickers-Armstrong, the designers and makers of the Viking, has been brought to a successful conclusion. It has been established that the building up of ice on parts of an aircraft can be sufficient to force it down, and that the meteorological conditions necessary to cause this may possibly be met on normal everyday flights. Consequently, equipment for dealing with the trouble must be provided on all machines that are expected to carry out flights to arranged schedules and timetables. Methods already tried out for dispersing this ice are: (i) application of heat, (ii) cracking the ice by causing the surfaces to pulsate, (iii) spraying the parts with a de-icing fluid. The latter system was adopted by Messrs. Vickers-Armstrong, and the experimental machine carrying it was flown by the B.E.A.C., as operators of an air transport line, under conditions chosen to be as bad as possible. The system was tried both by allowing ice to accumulate and then dispersing it, and by keeping the apparatus working and preventing the formation of ice. The fluid is sprayed over the wings, tail and control surfaces by means of porous metal distributors inset at the leading edges. It is pumped to these and carried back over the surfaces by the airstream, and is controlled manually by the crew or automatically by an ice detector. Normal flow is on an intermittent pulsation of one 'on' and four 'off' strokes; but in an emergency this can be increased to a continuous flow. To wet the surfaces quickly, when the system is first switched on, the normal intermittent flow is automatically preceded by a short flooding period of continuous pumping.

Pilot Papers

Pilot Papers, No. 4, is unfortunately not quite up to the standard of previous numbers in point of scientific interest (1, Nov. 1946. Pilot Press, Ltd. 3*s.* 6*d.*). The articles are too scattered in subject-matter and some of them superficial—too long and too 'thin—in treatment. The scattering of interest militates against *Pilot Papers* filling an obvious gap in learned sociological periodicals. Departmental libraries of universities, not to mention university specialists, may well hesitate to subscribe to yet another review for the 'general reader'. One article on the income tax is straight public finance, which is already catered for in economic journals; another is social history in autobiographical form. Two articles, clearly of sociological import, one on the 'squatters', the other on an estate of 'prefabs', are both too long for the common-sense and simple conclusions reached—such as that 'prefabs' are popular; though admittedly data on the 'sense of community' are useful to planners. In particular, the photographs of life among the prefabs might well have been halved without missing the peculiar characteristics of the community. A further article is a popularly written account of progress in psychosomatic medicine. The contribution of perhaps deepest interest deals with the question "Do the Germans Feel Guilty?" by direct interrogation of Germans.

The introductory 'commentary' by the editor, Mr. Charles Madge, is, however, disarming and certainly makes the best of interpreting the material presented. The comment on several articles is that they add something which journalists have missed. Certainly, they are super-journalism, but in the absence of comparison, generalization and interpretation, this does not qualify the essays as social science, such as Mr. Madge's own commentary certainly is. *Pilot Papers* have undoubtedly an important part to play in the advancement of the social sciences, at present so backward in Britain. Let us hope future numbers will concentrate more on an anthropological treatment of modern social relations or on comment thereon, less on *rapportage*, however superior.

Glossaries of Geographical Terms in Different Languages

The Royal Geographical Society, through its Committee on Geographical Names for British Official Use, published during the War a number of glossaries of geographical and other terms used on maps of various countries, most of which do not use the Roman alphabet (London: Royal Geographical Society). These glossaries covered Modern Greek, Russian, Albanian, Serbo-Croat and Slovene, Romanian, Siamese and Turkish. The volumes differ a little in scope, but all are glossaries as apart from gazetteers, and they are not concerned with the transliteration of proper names beyond including alphabets and equivalents. Several incorporate new systems of transliteration. Mr. M. Aurousseau, the secretary of the Place Names Committee, contributes to each volume a general article on the writing of geographical names, with a short bibliography on the subject. There are also articles on various linguistic aspects in many of the volumes. The Turkish volume gives both Arabic and Roman script, and the Siamese volume gives both Thai and Roman. These glossaries are invaluable in the utilization of the maps of the countries concerned; nothing else on so comprehensive a scale has been published for a very long time.

Commercial Flower Production

The Ministry of Agriculture and Fisheries has recently reprinted three booklets on the production of ornamental plants for market. Bulletin No. 109 (London: H.M. Stationery Office. 1*s.* 6*d.* net) deals with summer flowers; Bulletin No. 110 (1*s.* net) describes the horticulture of plants with decorative foliage; and Bulletin No. 112 (2*s.* net) considers the treatment of pot plants. All three bulletins have been written by Dr. H. V. Taylor and Dr. Katharine H. Johnstone. A general section on the raising of seedlings appears in each number, and descriptions of the varieties, cultivation and any special technique are given for each species. Length of text for a particular species is in proportion to its market value, and though the bulletins have no pretence to the encyclopædic, the grower will find that commercial factors have all been dealt with adequately. A number of drawings by L. N. Staniland illustrate the bulletin on foliage; the others have a smaller number of half-tone photographs. Part 1 of the series dealt with spring flowers and flowers grown under glass; it appeared first in 1936. The three booklets now reprinted should provide a modern compendium for growers who may be attempting to restore pre-war floral glories.

Wellcome Marston Archæological Research Expedition

PUBLICATION of the excavations conducted by the late Mr. J. L. Starkey at Lachish (Tell ed-Duwir), Palestine, during 1932–38 is now being resumed. In order to compile a full bibliography, the editor would be glad to know of all articles and other published references to the archæological and linguistic material from the site, particularly those in foreign publications. Copies or extracts, with full references and short summaries of the contents, should be addressed to the Wellcome Marston Archæological Research Expedition, at the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1.

Hydrogen-Cooled Turbo-Alternators

THE advantages of hydrogen cooling for large high-speed electrical machines have not up to now been exploited in Great Britain. Several manufacturers are at present engaged on the construction of turbo-alternator units employing hydrogen as a cooling agent. In a report on work and progress in 1946 issued by the Metropolitan-Vickers Electrical Co., Ltd., it is stated that a 60,000 kW., 3,000 r.p.m. set is approaching completion and will be ready for testing shortly.

Prizes for Scientific Instrument Development

THE British Scientific Instrument Manufacturers' Association has received from Mr. W. Bowen a substantial capital sum, the income from which is to be used for the encouragement and development of invention, design, research processes and manufacturing technique in the scientific instrument industry. The Council of the Association has therefore drawn up a trust deed under which the income will be devoted to prizes for employees of members of the Association. This year, five prizes totalling approximately £125 will be awarded for papers coming within the scope of Mr. Bowen's gift. Papers must reach the Secretaries of the Association, Messrs. Binder, Hamlyn and Co., River Plate House, 12/13 South Place, London, E.C.2, from whom application forms can be obtained, not later than April 30.

Colonial Service: Appointments

THE following appointments have been made in the Colonial Service: I. G. Bulmer, to be assistant conservator of forests, Sierra Leone; Captain A. T. Crow, to be geologist, Gold Coast; Captain M. Maughan, to be computer, Lands, Mines and Surveys Department, Uganda; C. A. Gibson-Hill, to be assistant curator, Raffles Museum, Singapore; J. N. Milsum, senior agricultural officer, Malaya, to be chief field officer, Malaya; R. G. H. Wilshaw, senior chemist, Malaya, to be chief research officer, Malaya; H. C. King, assistant conservator of forests, Mauritius, to be senior assistant conservator of forests, Sierra Leone.

The Night Sky in April

FULL moon occurs on April 5d. 15h. 28m., U.T., and new moon on April 21d. 04h. 19m. The following conjunctions with the moon take place: April 8d. 22h., Jupiter 0·6° N.; April 18d. 06h., Venus 4° N.; April 19d. 06h., Mercury 2° N.; April 19d. 07h., Mars 4° N.; April 27d. 13h., Saturn 4° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Mars on April 19d. 23h., Mercury being 1·8° S. Mercury rises about half an hour before sunrise at the beginning of April and attains its greatest westerly elongation on April 5. At the middle and end of the month the planet rises about 20 minutes and 10 minutes respectively before sunrise, and is not favourably placed for observation. Venus can be seen as a morning star, stellar magnitude −3·5, rising at 4h. 40m., 4h. 18m., and 3h. 56m. at the beginning, middle and end of the month, respectively. The visible portion of the illuminated disk varies between 0·748 and 0·820 during April. Mars is too close to the sun for favourable observation. Jupiter can be seen late in the evening in the constellation of Libra, and rises at 22h. 45m. on April 1 and 20h. 35m. on April 30. Its stellar magnitude is −2, and its altitude is not more than 21° in the latitude of Greenwich as its declination is far south. Saturn can be seen up to the early morning hours in the constellation of Cancer, setting at 3h. 31m., 2h. 37m., and 1h. 40m., at the beginning, middle and end of the month, respectively. The following occultations of stars brighter than magnitude 6 take place: April 23d. 20h. 28·4m., 247 B. Taur. (*D*); April 26d. 23h. 15·7m., κ Gemi. (*D*); April 29d. 19h. 56·3m., 46 Leon. (*D*); *D* refers to disappearance, and the latitude of Greenwich is assumed. During April 18–24 the Lyrid meteor shower is active, the radiant being about R.A. 18h., Dec. + 33°.

Announcements

THE following appointments have been made in the University of Leeds: Dr. Philip George, as Brotherton research lecturer in physical chemistry; Dr. G. E. Pringle, as lecturer in inorganic and physical chemistry.

A COURSE of eight lectures on microscopy will be given in the Physics Department, Imperial College of Science and Technology, London, S.W.7, by B. K. Johnson on Tuesdays and Thursdays at 4 p.m., commencing on April 29. The lectures will be accompanied by practical demonstrations and will include modern methods. They will be suitable for those having to use the microscope in technical practice. Application for admission should be made to the Registrar of the Imperial College, Prince Consort Road, S.W.7.

THE twenty-first National Colloid Symposium will be held at Stanford University, Palo Alto, California, during June 18–20, 1947, under the auspices of the Division of Colloid Chemistry of the American Chemical Society. The programme will consist of two groups of papers; one of these will be built about the subject "Colloidal Electrolytes"; the other will be made up of papers on general colloid chemistry. Particulars of the meeting can be obtained from Prof. J. W. Williams, Department of Chemistry, University of Wisconsin, Madison 6, U.S.A.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Use of Punched Card Tabulating Machines for Crystallographic Fourier Syntheses

THE use of 2-dimensional Fourier syntheses in the determination of crystal structures from X-ray data has been well established for some years; but it is becoming increasingly recognized that for detailed determinations these alone are not enough, and that 3-dimensional syntheses are also necessary. The methods of summation which have been used for 2-dimensional work[1], and which employ no other mechanical aids than adding machines, can be applied to 3-dimensional problems, but are then comparatively slow and impose a considerable strain on the computer. Moreover, with rising standards of accuracy, some improvement is desirable on the existing Beevers–Lipson strips which have so far been most commonly used for 3-dimensional work; the 'rounding-off' errors arising from the use of the strips, with their 2-figure accuracy and 6° intervals of computation, may in unfavourable cases lead to displacements of atomic centres by 0·01 A., which is now no longer small compared with the accuracy theoretically attainable[2].

The possibility of carrying out syntheses by means of punched card tabulating machines has been appreciated for some time[3], and several 3-dimensional syntheses have been performed in Great Britain by the Scientific Computing Service, Ltd., while recently Shaffer, Schomaker and Pauling[4] have described a method for use with American tabulating machines. In order to fulfil our requirements for a simplified punched card method, capable of operation locally, we have developed independently the method outlined below; this, while not essentially different in principle from that of Shaffer *et al.*, is considerably simpler, so that the selection of cards can be done by any research worker in a reasonable time and without special training, and can be carried out on Hollerith machines of the type commonly available in Britain. The machines do not have to be adapted specially or set aside for crystallographic work only, so that syntheses or parts of them, occupying, say, two or three hours, can be done in intervals between the normal commercial work of the machines.

We have in effect reproduced Beevers–Lipson strips on Hollerith cards, but with higher accuracy, and, owing to the method of calculation adopted, with a decrease in the number of cards. The 'master pack' of Hollerith cards, for sines and cosines up to order 20, totals 492 cards, while the following advantages over the existing Beevers–Lipson strips are obtained: (*a*) the interval in the argument is 3° instead of 6°; (*b*) the values of the functions are entered to four figures to ensure certain 3-figure accuracy in the final result; (*c*) although cards are punched for amplitudes of 1, 10 and 100 only, the method of working enables any 3-figure amplitudes to be employed.

In practice, we find it convenient to duplicate each card about thirty times, but the number of *different* cards remains 492, and since sines and cosines are never handled simultaneously, the maximum number of different kinds of cards to be dealt with at any one time is 252. With this small number it becomes possible to devise simple systems of picking out the cards required by hand in the laboratory, without the assistance of trained operators or Hollerith sorting machines.

The cards are kept in a pigeon-hole system (details of which are a matter of individual choice) and the 492 pigeon-holes are divided into eight sets according as the cards are sines or cosines; positive or negative; and odd or even multiples of 3° (a particular card contains entries of the function for 3°, 9°, 15°, etc., or 6°, 12°, 18°, etc.; in this way, when circumstances do not justify 3° intervals in the calculations, only the even cards need be used). Each pigeon-hole contains about thirty identical cards.

The selection of the cards for a synthesis follows the same general lines as for the selection of Beevers–Lipson strips, with one important difference. Nine 'digiting cards' are laid out in order and numbered 1 to 9; a 3-figure amplitude (say, 359) is selected by picking one each of the appropriate 1, 10 and 100 cards, and placing them on the 9, 5 and 3 digiting cards respectively. This process is repeated until all the amplitudes required have been selected, and the nine packs of cards are then put together in order, and are ready to be checked and go through the tabulating machine (usually with other similar packs for other parts of the calculation, separated by spacing cards).

Avoidance of errors in hand-picking is largely a matter of the lay-out of the pigeon-hole system and the establishment of a suitable routine; but as complete freedom from error cannot be assumed, the odd and even cards, which are picked separately and should be identical as regards amplitude and order, are put through a comparing reproducer, which detects differences between the two sets.

In the tabulator, each entry on the cards is multiplied by the number of the adjacent digiting card before being incorporated in the appropriate total; it is for this reason that entries on the cards are made to four figures, so that the effect of rounding off the fifth place, even when multiplied by nine, cannot affect the accuracy of the third place.

The results of the tabulation (either actual electron densities or intermediate data according to the stage of the syntheses) may be printed on paper or punched on Hollerith cards (for filing or subsequent use), or both. To complete the work, the cards which have been used are sorted back into pigeon-hole order on a sorting machine.

The time taken for a synthesis depends upon the particular circumstances of each case, but the order of magnitude may be inferred from the following example. We evaluated the appropriate 3-dimensional section to locate one of the central (CH_2) carbon atoms in dibenzyl, using 3-figure values of the structure factors determined by Jeffrey[5]. The whole operation took two persons approximately ten hours, of which about half was spent in the laboratory selecting and preparing the cards, and half at the machines, comparing, tabulating and re-sorting. There was an appreciable loss of time on account of the improvised nature of our pigeon-hole system and of our inexperience, so that we think with practice it should be possible to reduce the time for a similar computation by several hours.

Nevertheless, it will be clear that to determine, by our method, the electron density throughout, say, one quarter of a unit cell, involving perhaps sixty 3-dimensional sections, would be a very lengthy process. We wish, therefore, to emphasize that it has not been our aim to provide for comprehensive syntheses of this type, which are not necessary in dealing with the comparatively small molecules in which we are interested, and which at the present time can be carried out efficiently only by a centralized computing service, to which our method should be regarded as complementary. Our procedure, which we consider to be sufficiently simple to be within the reach of any laboratory engaged on accurate structure analysis, is particularly adapted to the evaluation of electron densities with good accuracy over limited areas; for example, in regions where atoms are indicated by 'trial and error' or other preliminary investigations. The methods of selecting the cards and of tabulating confer a flexibility which enables this to be done with equal ease for any part of the unit cell, and by restricting calculations to regions which contain details of interest, it becomes feasible to use the Hollerith method not only for final syntheses but also for some, at least, of the preceding ones too.

We shall be glad to give working details of this method to anyone who is interested.

We wish to thank Mr. W. McL. Wishart and Mr. J. L. Ineson of the Central Electricity Board for placing Hollerith machines at our disposal, Messrs. Bartindale, Cruickshank, Gillot, Nyburg and Stadler for help in carrying out trials, and Mr. J. Grant of the British Tabulating Machine Co. for his helpful interest.

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[1] For example, Robertson, J. M., *Phil. Mag.*, **21**, 176 (1936). Lipson, H., and Beevers, C. A., *Proc. Phys. Soc.*, **48**, 772 (1936).

[2] Cf. Booth, A. D., *Nature*, **156**, 51 (1945).

[3] For example, Comrie, L. J., in discussion on paper by Beevers, *Proc. Phys. Soc.*, **51**, 660 (1939).

[4] *J. Chem. Phys.*, **14**, 648 (1946).

[5] *Proc. Roy. Soc.*, A, **188**, 222 (1947).

Orientation of Fibrils in Natural Membranes

In recent years, several studies of the orientation of chitin and protein chains in the insect cuticle[1,2] and of cellulose chains in plant cell walls[3] have appeared. Between 1938 and 1940, X-ray, optical and chemical studies of the cuticle of annelids and nematodes were made by one of us (L. E. R. P.) with the idea of obtaining information about the structure of other types of natural membranes. The cuticles of these animals are largely composed of fibrils of a protein belonging to the collagen group, distributed with their long axes in the plane of the cuticle and in two preferred orientations with respect to the long axis of the body. In annelids, such as *Aphrodite* and *Lumbricus*, the fibrils cross at *c.* 90°, and each set makes an angle of *c.* 45° with the long axis. In *Ascaris*, the two sets make an angle of *c.* 135° with each other and of *c.* 70° with the long axis. An arrangement of this kind may be mechanically advantageous, since the resulting membrane is capable of anisometric extension, though the individual fibrils are inextensible.

It has been suggested[4] that the cellulose chains in plant cell walls are deposited in sheets, alternately oriented in one or other of two preferred directions, and that this orientation depends on control exercised by the protoplasmic surface of the cell. The preferred orientation of fibrils in membranes bounding grossly macroscopic organisms, such as round and bristle worms, where the cuticle is formed by a hypodermis composed of millions of cells, would seem to require a high degree of co-ordination of the activities of these cells, if orientation depends on the protoplasmic surface beneath the cuticle. The mechanical aptness of fibrillar orientation in the cuticle, however, invites an alternative hypothesis: that shear and/or tension forces acting during secretion may be responsible for the observed orientation.

In the filamentous alga *Chætomorpha linum*, it has been shown[5] that both longitudinally and transversely oriented cellulose chains are present in each of the microscopically visible lamellæ of the cell wall. A macroscopic system in some respects similar has been studied in the cocoon of the chrysomelid beetle *Donacia*. Although first deposited as a viscid mass surrounding the larva[6], this barrel-shaped, chitinous cocoon afterwards hardens, becomes laminated, and exhibits positive birefringence with respect to the shorter diameter after freeing from sclerotin. The organisation of the cocoon cannot in this case be due to the intervention of a protoplasmic surface. Recently, one of us (M. M. S.) has shown that the thinnest single laminæ which can be separated from the *Donacia* cocoon are mosaics of birefringent and isotropic regions. If the extinction directions in a number of laminæ are plotted against frequency in a polar diagram, it is found that the chitin chains are oriented predominantly at 45° and 90° to the long axis of the cocoon.

These observations on different types of macroscopic cuticular membranes suggest that (*a*) 'crossed fibrillar'[3] orientation can occur at the surface of cylindrical units of a very different order of size from that of single cells; (*b*) preferred orientation of fibrils with respect to the morphological axes of the unit may be due to mechanical forces acting during deposition; (*c*) contact with a protoplasmic surface is not essential for the formation of a laminated membrane with two preferred orientations of chitin chains; (*d*) preferred orientation in two directions may occur within a single microscopic lamina of a multilaminate, macroscopic membrane.

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M. M. Swann

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Feb. 6.

[1] Fraenkel and Rudall, *Proc. Roy. Soc.*, B, **129**, 1 (1940).

[2] Fraenkel and Rudall, *Proc. Roy. Soc.*, B, **134**, 111 (1947).

[3] Preston, *Proc. Roy. Soc.*, B, **133**, 327 (1945).

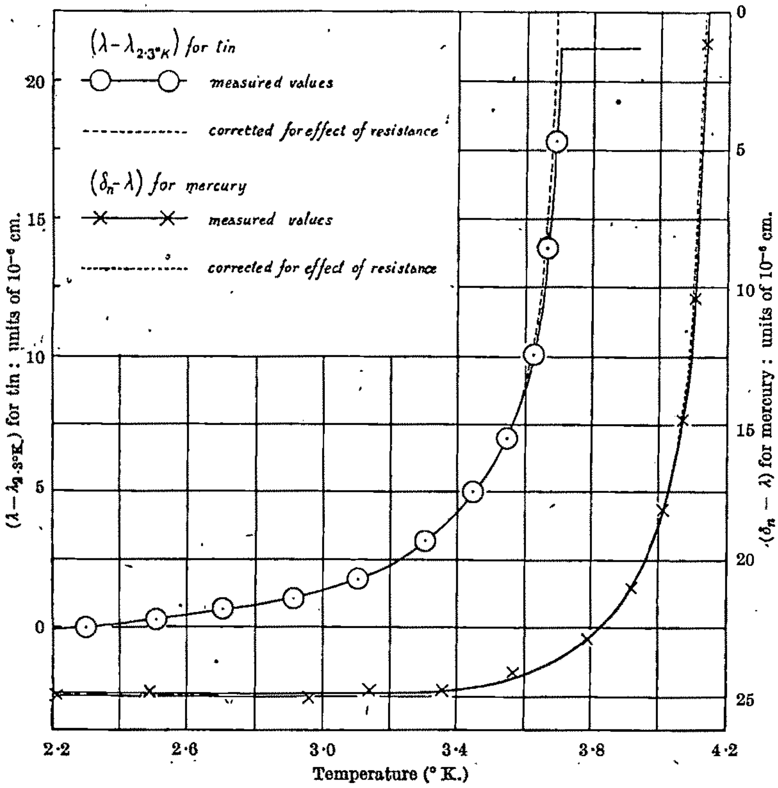
[4] Preston and Astbury, *Proc. Roy. Soc.*, B, **122**, 76 (1937).

[5] Nicolai and Frey-Wyssling, *Protoplasma*, **30**, 403 (1938).

[6] Böving, "Natural History of the Larvæ of Donaciinæ" (Leipzig, 1910).

A New Method for Determining the Penetration Depth in Superconductors

It is a well-known property of high-frequency electrical transmission lines[1] operating in the normal mode that the velocity of propagation of a wave along the line is given by the equation $v = 1/\sqrt{LC}$, where L and C are the inductance and capacitance per unit length. But whereas for all frequencies used in practice the value of C is simply the electrostatic



capacity between the conductors, the inductance must be considered as the sum of the two quantities, usually referred to as the internal and external inductances. The latter, $L_{\text{ext.}}$, is the value that would be assumed by the inductance if all the current were to flow on the surface, and the internal inductance, $L_{\text{int.}}$, represents a correction, very small at high frequencies, due to the finite penetration of the current into the body of the conductors. If the internal inductance be neglected, as indeed is common, the velocity is found to be in general the velocity of propagation of a plane unbounded wave in the dielectric medium surrounding the transmission line. The effect of the internal inductance is to alter the velocity by a factor $(1 - L_{\text{int.}}/2L_{\text{ext.}})$.

For the special case of the parallel-wire transmission line, formulæ have been developed for the capacitance and external inductance of the line; in order to take into account the internal inductance, the simplest procedure is to calculate C from the actual dimensions of the line, but for the calculation of L to imagine the radii of the conductors to be reduced by a quantity δ, which represents the effective skin-depth of the current. It is easy to show that for a normal metal obeying the classical conduction equation $J = \sigma E$, δ takes a value equal to one half of the skin-depth as usually defined, that is, $\delta = \dfrac{1}{2\sqrt{2\pi\omega\sigma}}$, while for a superconductor obeying the equations of F. and H. London[2], δ is the same as the penetration depth, λ.

Now it is very difficult to measure the velocity of propagation sufficiently accurately to determine δ directly, but it is a far easier problem to measure with considerable accuracy small changes in the velocity due to variations of δ. It was observed during experiments on the radio-frequency resistance of superconductors at a wave-length of 25 cm., using the parallel wire resonator described previously[3], that a change in resonant frequency occurred when superconductivity was destroyed by a magnetic field. Clearly there must be an alteration in the velocity of propagation, which is associated with a difference in the values of δ for the superconducting and normal states. This phenomenon may be used in certain circumstances to measure variations of λ with temperature; but unfortunately there seems to be little hope at present of using it for an absolute determination of λ, since a detailed investigation, to be published elsewhere, has verified the suggestion of H. London[4] that most metals at very low temperatures behave anomalously owing to the very long mean free paths of the electrons. Consequently, it is not possible to calculate the value of δ_n in the normal state from a knowledge of the skin resistance. If, however, as in the case of tin, the normal skin resistance, and hence presumably δ_n, is constant within 1 per cent between 4° K. and zero, measurements at various temperatures of the resonant frequency change which occurs when the magnetic field is applied enable the variation of λ with temperature to be studied. This variation is shown in the diagram, from which it may be seen that the method is capable of an accuracy of about 1 per cent.

The present determination was made without any refinement of the apparatus beyond that required by the resistance measurements already quoted, and the estimated probable error is $\pm 0{\cdot}2 \times 10^{-6}$ cm. Just below the transition temperature, it is necessary to apply a small correction for the influence of the radio-frequency resistance on the depth of penetration. The theory of this correction will be discussed in a more detailed account of the experiments to be published elsewhere.

On the same graph is shown the variation of the difference between δ_n and λ for mercury, but since here the normal skin resistance, and hence probably δ_n, varies with temperature, the interpretation of the curve is more difficult. It may be said, however, that this curve does not exhibit any gross divergences from the more direct determinations of λ[5]. Preliminary (unpublished) measurements on tin by the same authors show qualitative agreement with the results of the present method.

In conclusion, I should like to express my thanks to Dr. M. Désirant for his help in carrying out these experiments.

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Feb. 11.

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[1] See, for example, Jackson, Willis, "High Frequency Transmission Lines" (Methuen).

[2] London, F., and London, H., *Physica*, 2, 341 (1935).

[3] Pippard, *Nature*, 158, 234 (1946).

[4] London, H., *Proc. Roy. Soc.*, A, 176, 522 (1940).

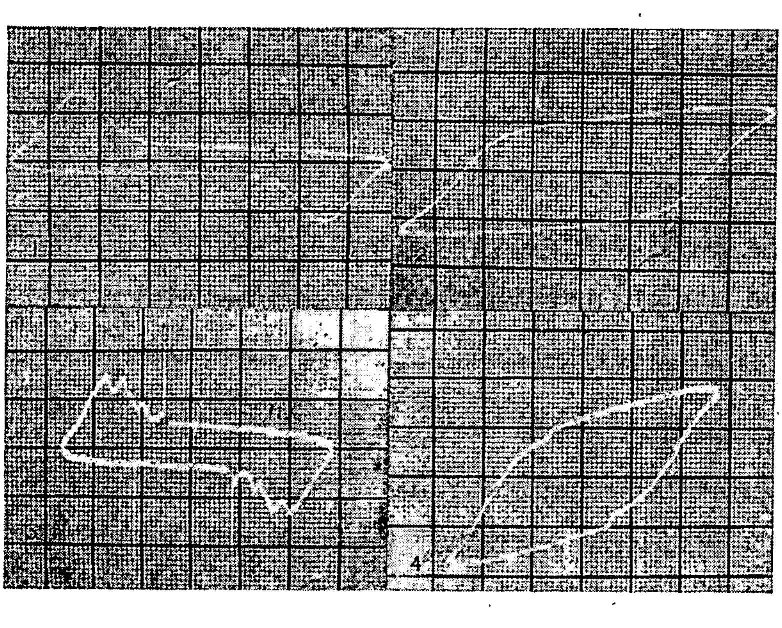
[5] Shoenberg, *Proc. Roy. Soc.*, A, 175, 49 (1940). Désirant and Shoenberg, *Nature*, 159, 201 (1947).

A New Method of Studying the Structure of Alloys by Magnetic Analysis

In testing metal wires for ferromagnetism in this laboratory, a cathode ray oscilloscope is used to exhibit either of two curves, one showing the variation with the external field strength H of the rate of change of magnetic intensity $\frac{dJ}{dt}$ in a single wire, the other the hysteresis loop J v. H. By a simple calculation the values of the former can be transformed into values of $\frac{dJ}{dH}$, that is, the differential susceptibility, K_d.

With wires of homogeneous material, both traces appear as smooth curves throughout the range of applied field strengths (Figs. 1 and 2). The differential curve shows a pronounced peak or bulge corresponding to the steepest part of the hysteresis loop, the general form of the curve being very similar to those given by Bozorth and Dillinger in their classical work on the volume concerned in a Barkhausen discontinuity.

A number of 'tested' wires, however, have shown pronounced irregularities in this curve in the form of subsidiary peaks which in extreme cases rise like needles to a height exceeding that of the main peak of the curve (Fig. 3; the largest peak, although visible on the negative, was insufficiently defined for adequate reproduction, and has, therefore, been drawn in to the same height as on the negative). They may occur singly or in clusters, which usually contain at least one main peak, and several such clusters may be exhibited on one curve. With an applied field in excess of the value at the main peak, these irregularities are spaced over the portion of the curve corresponding to the section of the hysteresis loop between the knee of the demagnetization quadrant and the steepest part; and it has been found that the values of H at which they occur remain constant as the applied field is reduced, although the optical effect is that of movement towards the main peak, since the latter occurs at lower values of H with low applied field strengths. The more pronounced of these irregularities are easily observed as step discontinuities in the hysteresis loop (Fig. 4).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Since the irregularities are found to vary in intensity as different points on the same wire are examined, it is obvious that they are caused by inhomogeneities of structure such as may be due, for example, to imperfect annealing. It is considered that they represent 180° reversals of demagnetized domain orientation of magnetization at values of H corresponding to the critical value H_0 for different ferritic combinations of the constituents of the wire, and that their appearance in any material would indicate the presence of alloy micro-structures (whether agglomerates or transition zones) of differing coercivities.

Further investigation is proceeding, and it has already been found that in certain circumstances the effect can be produced by suitable heat treatment of an otherwise normal wire at temperatures which are known from other sources to be suitable for precipitation processes at grain boundaries for the alloy examined.

The method described would, therefore, appear to be suitable for the examination of the structure of inhomogeneous alloys exhibiting ferromagnetism. This preliminary account is put forward as possibly of interest to other investigators, since, so far as is known, no other observations of this type have been published.

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Radioactivity of Radioaluminium

In a recent letter in the *Physical Review* by Sachs[1] and one in *Nature* by Allan and Clavier[2], and in several papers during the war years, reference is made to the disintegration of radioaluminium according to the reaction

$$^{28}\mathrm{Al} \rightarrow {}^{28}\mathrm{Si} + e^{-}.$$

The β-particle spectrum has been measured by Cork, Richardson and Kurie[3], who find a maximum energy of 3·3 MeV., and by Eklund and Hole[4], who find a maximum of 2·98 (± 0·18) MeV. The shape of the spectrum suggests a simple transition. γ-Radiation has been observed and estimated as 1·8 MeV. by Itoh[5], and 2·05 (±0·15) MeV. by Eklund and Hole[4].

A paper by Watase[6] in 1941 described coincidence experiments which showed that all β-particles from radioaluminium were followed by the same amount of γ-radiation. There was no evidence for γ-rays in cascade.

Absorption and coincidence experiments were carried out by me in 1939 [7,8], which are in full accord with the Japanese work and showed that the β-spectrum was substantially simple. The maximum energy of the β-particle spectrum was estimated as 3·10 (±0·10) MeV., and no change in β–γ coincidence-rate per β-particle was observed up to absorption thicknesses of 480 mgm. per sq. cm. of aluminium. No γ–γ coincidences could be detected, and the β–γ coincidence-rate per γ quanta indicated that all γ-quanta were correlated with the main β-particle spectrum. It is therefore certain that in most aluminium disintegrations a simple β-particle spectrum of maximum energy about 3 MeV. is followed by a single γ-quantum. The coincidence experiment gave a net efficiency of detection of the γ-quanta corresponding to an energy of 2·15 MeV., in rough agreement with the estimates given above.

Accepting the energies given by Eklund and Hole[4], the disintegration energy of radioaluminium is 5·03 (± 0·23) MeV., and not a value of about 3 MeV. as given by Mattauch and other investigators[1,9,10].

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Jan. 31.

[1] Sachs, *Phys. Rev.*, 70, 567 (1946).

[2] Allan and Clavier, *Nature*, 158, 832 (1946).

[3] Cork, Richardson and Kurie, *Phys. Rev.*, 49, 208 (1936).

[4] Eklund and Hole, *Ark. Mat. Ast. Phys.*, 29A, No. 26 (1943).

[5] Itoh, *Proc. Phys. Math. Soc. Jap.*, 23, 605 (1941).

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[7] Dunworth, *Rev. Sci. Instr.*, 11, 167 (1940).

[8] Dunworth, Ph.D. thesis, Cambridge (1941).

[9] Mattauch, "Kernphysikalische Tabellen" (Springer, 1942).

[10] Saha and Saha, *Trans. Nat. Inst. Sci. India*, 2, 193 (1946).

Occurrence of a Monotropic Transformation in Trinitroanisole

A STRIKING example of the persistence of the metastable crystalline modification of a substance in the absence of nuclei of the stable form has recently been experienced in this Laboratory.

During the seven months prior to January 18 of this year, all efforts to prepare pure trinitroanisole here, either from picryl chloride or from dinitroanisole, consistently resulted in producing a substance melting sharply at 57·5° C. as compared with the figure of 68° C. normally expected for trinitroanisole. Ultimate analysis gave the results to be expected for this material, and somewhat elaborate chromatographic treatments served to confirm its high state of purity.

A sample of normal trinitroanisole melting at 68° C. was introduced into this Laboratory on January 18, since when all fresh local preparations of the substance have melted at 68° C. Moreover, all material previously melting at 57·5° C. was almost immediately transformed to the more stable modification on exposure to the air of the laboratory.

β-Trinitroanisole was prepared afterwards by sealing small quantities of the stable α-form in glass tubes, which were then completely immersed in boiling water to destroy all crystalline form. After supercooling, crystallization was induced by means of loose pieces of glass rod originally introduced with the crystals. In this way, the β-form was usually produced, and could be preserved for some time in the metastable state. When such a tube was broken in a 'contaminated' atmosphere, transformation commenced almost immediately, even above the melting point of the β-form.

By inducing crystallization of the β-form at the centre of a supercooled film on a microscope slide, the transformation could be initiated at a corner of the film and observed through a polarizing microscope. The rate of transformation, as measured by the movement of the new crystal face across the film, became slower with rise of temperature, thus confirming the monotropic nature of the change.

There is an interesting historical aspect of this observation. In 1903 Holleman[1] expressed his astonishment at his failure to prepare trinitroanisole melting above 58° C. He sent a sample of his material to Hantzsch[2], who stated that when it was purified he obtained material of normal melting point. There seems no doubt now that Holleman's preparation consisted of the metastable form, and it is conceivable that when Hantzsch exposed it to the air of his own laboratory it would have been transformed without the necessity for further purification. In 1924 Van de Vliet[3], who is believed to have worked in the same laboratory as Holleman, published further evidence in support of a melting point of 58° C., having failed to obtain a higher figure. Evidently this is a case where the metastable form persisted for more than twenty years.

I wish to thank Dr. O. L. Brady, of University College, London, for his interest and suggestive comments in connexion with the transformation.

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Feb. 5.

[1] Holleman, *Rec. trav. Chim.*, 22, 269 (1903).

[2] Hantzsch, *Ber.*, 39, 3074 (1906).

[3] Van de Vliet, *Rec. trav. Chim.*, 43, 621 (1924).

The Boron-Trifluoride Catalysed Reaction of Di-isobutene

THE polymerization of isobutene and the dimerization of di-isobutene are both catalysed by Friedel–Crafts catalysts. Earlier work on these reactions has led to the conclusion that a third component, other than the Friedel–Crafts catalyst and the monomer, is necessary for an appreciable reaction-rate to occur; and it has been shown, in particular, that the rapid polymerization of isobutene in the gas phase, using boron trifluoride as catalyst, does not occur if these reactants are pure, but does occur if a trace of water is present[1].

We have now used high-vacuum technique to study the reaction of di-isobutene in the gas phase at room temperature with boron trifluoride as catalyst. The pressures of di-isobutene and of boron trifluoride were each of the order of 20 mm. Unpurified di-isobutene vapour reacts rapidly on mixing with boron trifluoride. (The reaction is observed by the fall in pressure.) Di-isobutene vapour, purified by several distillations *in vacuo* over freshly distilled sodium at 60° C., does not react on mixing with boron trifluoride.

Di-isobutene vapour, purified in this way, was mixed with boron trifluoride, and to this non-reacting mixture a small quantity (2–3 mm. pressure) of the vapour of some third component was added. In some cases the addition of the third component caused the di-isobutene to react rapidly. This occurred when the third component was water or acetone. In these experiments the boron trifluoride combined instantaneously with the added vapour of the third component in approximately equal molar quantities. The acetone was purified by distillation *in vacuo* over freshly distilled sodium.

In other cases, the addition of the third component did not produce a rapid reaction of the di-isobutene, and the boron trifluoride did not combine with the added vapour. Examples of this class which we have studied are oxygen, hydrogen sulphide and hydrogen chloride. In each of these cases, the final addition of water vapour to the non-reacting mixture produced rapid reaction.

The addition of ammonia vapour to the non-reacting catalyst-monomer mixture results in the instantaneous combination of the ammonia with the boron trifluoride, in approximately equal molar quantities, but has no effect upon the di-isobutene reaction. The subsequent addition of water vapour to this mixture produces the rapid reaction of di-isobutene.

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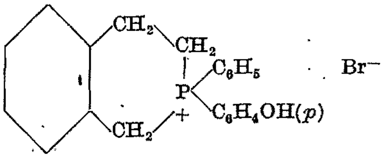
[1] Evans, A. G., Meadows and Polanyi, *Nature*, **158**, 94 (1946). See also Evans, A. G., Holden, Plesch, Polanyi, Skinner and Weinberger, *Nature*, **157**, 120 (1946). Evans, A. G., and Polanyi, *J. Chem. Soc.*, in the press. Plesch, Polanyi and Skinner, *J. Chem. Soc.*, in the press.

An Optically Active Quaternary Phosphonium Salt

OF organic derivatives of phosphorus (that is, containing C—P links), the only type which has hitherto been resolved into optically active forms is that represented by the general formula $R^1R^2R^3P\rightarrow X$, where R^1, R^2 and R^3 are different alkyl or aryl groups and X is either oxygen or sulphur: Meisenheimer *et al.*[1] have resolved tertiary phosphine oxides, for example, phenyl-benzyl-methyl-phosphine oxide, and Davies and Mann[2] have similarly resolved phenyl-*p*-carboxymethylphenyl-*n*-butyl-phosphine sulphide.



We have now developed a general synthesis of 2 : 2-diaryl-1 : 2 : 3 : 4-tetrahydro-*iso*-phosphinolinium salts. One member of this series, namely, 2-phenyl-2-*p*-hydroxyphenyl-1 : 2 : 3 : 4-tetrahydro-*iso*-phosphinolinium bromide (see formula), we have resolved through the *d*-camphor sulphonate and isolated in the optically pure state having $\alpha_D + 0{\cdot}34°$, $[M]_D + 32{\cdot}9°$. This bromide shows considerable optical stability and undergoes no perceptible racemization when boiled in alcoholic solution.

This, therefore, represents the first example of an optically active quaternary phosphonium salt, a compound which, in general structure, is closely related to 2-phenyl-2-*p*-chlorophenacyl-1 : 2 : 3 : 4-tetrahydro-*iso*-arsinolinium bromide, the resolution of which we have recently recorded[3].

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Feb. 7.

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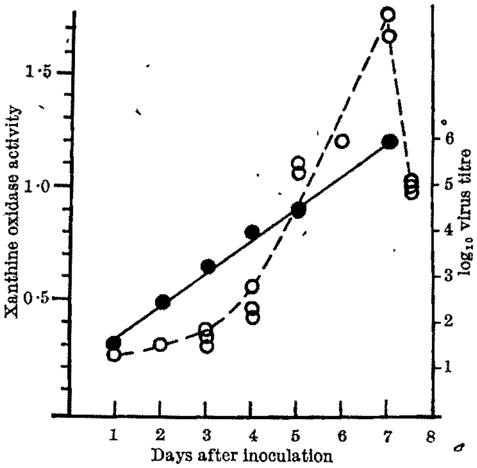
[1] *Ber.*, **44**, 356 (1911). *Ann.*, **449**, 224 (1926).
[2] *J. Chem. Soc.*, 276 (1944).
[3] *J. Chem. Soc.*, 550 (1943).

Xanthine Oxidase and Virus Growth

So far as is known, viruses appear to possess no enzyme activity; the virus particles, in order to multiply, must presumably utilize the enzyme-substrate reactions of the host cells, or else have a selective affinity for the products of host metabolism. It is thus possible that an investigation of the biochemical activities of tissues containing a growing virus might disclose an abnormality of enzyme action which would yield information upon the metabolic activities of the virus itself. With this object in view, preliminary studies have been carried out upon the xanthine oxidase content of the brains of mice with yellow fever encephalitis.

A group of mice were inoculated intracerebrally with 10^5 LD_{50} of the 17D strain of yellow fever virus. Each day after the inoculation a mouse was selected at random, the brain was removed, ground with 5 c.c. distilled water and centrifuged. The supernatant fluid was tested for xanthine oxidase activity by the Thunberg technique; a part of the supernatant liquid was also inoculated into mice in serial decimal dilutions in order to determine the titre of virus present. The results are shown in the accompanying graph.



●, virus titre. ○, xanthine oxidase activity

The titre of virus in the brain rises steadily to a maximum of 10^6 on the seventh day, when symptoms of encephalitis appear. Throughout this incubation period the amount of xanthine oxidase in the brain (expressed in arbitrary units) also rises. The normal level of enzyme activity in mouse brain lies between 0 and 0·2 in the units adopted; in the mouse brain infected with yellow fever virus, the activity rises to a value of 1·7 at the time of onset of symptoms. As paralysis increases the enzyme content falls, and reaches a value of 1 or less when the animal is moribund. Similar results were obtained with the neurotropic and Asibi strains of yellow fever virus, and with the virus of lymphocytic choriomeningitis.

The question naturally arises as to whether the observed increase of enzyme content in these virus infections is significant or purely a chance finding. As encephalitis develops, a round-cell infiltration of the brain appears, and it might be that these round-cells, presumably lymphocytes, attracted to the brain by an unknown stimulus, bring xanthine oxidase with them in an incidental manner. This point was investigated in two ways:

(*a*) Brains were removed at daily intervals during the incubation period. Each was divided into halves longitudinally; the xanthine oxidase activity of one half was determined while the other was fixed, sectioned and stained with hæmatoxylin and eosin. It was found that the xanthine oxidase activity had already considerably risen by the second day, whereas cellular infiltration did not appear until the third day and was not prominent until the fourth day after inoculation.

(*b*) Determinations were made of the desoxyribonuclease activity of normal and virus-containing mouse brains. No significant difference was found. This enzyme is present in large amounts in mouse lymphatic tissue; since the cellular infiltration is insufficient in amount to produce a detectable increase of desoxyribonuclease activity, it is not likely that it is responsible for producing the observed rise of xanthine oxidase activity, which at times amounts to ten times the normal value.

The evidence, therefore, does not support the view that xanthine oxidase is introduced into the brain by the accumulation of inflammatory cells, as it begins to increase in amount some considerable time before cellular infiltration appears. This being so, it is possible that the presence of the virus brings about in some way the accumulation of xanthine oxidase, perhaps by a selective affinity for it which is greater than that of the host tissues, and that the enzyme is an essential growth factor which is required for virus multiplication.

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The Premaxilla and the Ancestry of Man

IN 1914 I had the privilege, thanks to the kindness of the late Prof. Fawcett, of studying the development of the human facial bones in his unique series of embryonic crania. In 1918, as a result of this investigation, I stated in my first publication on the "Ancestry of Man" that absence of the premaxilla on the human face was "a human specific character", and that from its very precocious ontogenetic development it might be presumed to be a very early phylogenetic acquirement. This statement received a certain amount of adverse criticism, but I repeated it and amplified it again in "Man's Place among the Mammals" in 1929.

At the time I did not realize that my findings were merely a repetition of those made by G. W. Callender in his forgotten paper of 1869. In that paper Callender had shown that in man the premaxilla is "shut off from the face by the nasal and incisor processes of the superior maxilla". Afterwards, Dr. E. H. Johnson, working in my department in the University of Melbourne, repeated the whole of the work on the development of the upper jaw in 1936. These results may be briefly summarized:

(1) Notwithstanding the numerous statements to the contrary, the suture between the maxilla and premaxilla is never present on the human face at any pre- or post-natal stage. This is so because

(2) in early embryonic life the maxilla of each side grows forwards over the *anlage* of the premaxillæ and, by meeting in the middle line of the upper jaw, buries them completely on their facial aspect.

(3) In this way those parts—the portion of the upper jaw bearing the incisor teeth and the narial margins—which in monkeys and apes are formed superficially from the premaxilla are, in man, constituted by the medially growing incisor and nasal processes of the maxilla.

(4) The division between the superficial maxilla and the buried premaxilla in man is marked, as Jarmer showed in 1922, by the interalveolar suture; for in man alone are the sockets for the incisor teeth formed from maxilla labially and premaxilla lingually.

This striking fact of the fundamental difference between man and any other of the existing Primates in the architecture of the upper jaw appears to have been completely overlooked in assigning the rank of 'hominid' or 'man-apes' to the Taungs and Sterkfontein skulls. *Australopithecus* and *Plesianthropus* show definite facial maxillary–premaxillary sutures in typical simian form, and *Paranthropus* fails to show it only because the individual is over the age at which it is obliterated and not at all because the condition is 'as in man'.

Whether the orthograde bipedal posture and the other attributes that have been claimed for these South African forms will ultimately be established is a question that only time and further discoveries can solve. But meanwhile it can be asserted with every possible assurance that all of them are apes, and that they throw no light whatever on the primate forms that were ancestral to *Homo*.

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Species of Sulphur Bacteria Associated with the Corrosion of Concrete

IT has already been shown[1] that in the highly acidic end-products of corrosion of concrete sewers exposed to atmospheres containing hydrogen sulphide, there are present large numbers of a sulphuric acid-forming species of sulphur bacterium provisionally named *Thiobacillus concretivorus*. Further, it has been shown[2] that the typical corrosion process is a case of bacterial corrosion; it cannot proceed under sterile conditions and can only be carried to the acid stage through the activity of this organism. It is typical of this form of corrosion that the *p*H of the products falls continuously as the corrosion process becomes established. As the organism cannot exist at a higher *p*H than 6·5, its activity could not explain the initial stage of the process in which the *p*H of the fresh concrete surface (11–12) falls to 6·5 or less. It was then suggested that this preliminary drop in *p*H could be brought about either by purely chemical reactions or by the activity of further species of bacteria.

I have now isolated, from the corrosion products of concrete in the early stages of corrosion, two other groups of bacteria the activity of which explains this preliminary drop in *p*H.

The first group appears to be a homogeneous single species characterized as follows: the organisms are strictly autotrophic Gram-negative bacilli which rapidly oxidize thiosulphate to sulphate, polythionate and elemental sulphur, forming a pellicle of sulphur and reducing the pH of the culture medium to 3·0–3·3. They grow in a hydrogen sulphide atmosphere, in culture media containing excess calcium carbonate, forming a pellicle of sulphur and reducing the pH to the same value as with thiosulphate. They oxidize elemental sulphur slowly with the formation of sulphate, but do not oxidize alkali sulphides. The range of pH over which they exist varies slightly from strain to strain. It is between the approximate limits of 3·5–8·5; but these depend to some extent on the pH of the corrosion products from which the strain is isolated. This group resembles in many respects the species *Thiobacillus thioparus* isolated by Nathansohn[3] and studied by Beijerinck[4] and Starkey[5,6,7].

The second group consists of a miscellaneous collection of species characterized by considerable variation in colony form and morphology, but they are all facultatively autotrophic and grow profusely on nutrient media. They slowly oxidize thiosulphate to polythionates and sulphate without the formation of elemental sulphur, and in fact show little evidence of growth in mineral media; the pH first rises and then slowly falls to the initial pH of the medium. They tolerate a wide range of pH (2·0–10·5), but the optimum for growth is between 7 and 10. They can exist in a hydrogen sulphide atmosphere with calcium carbonate in the culture medium, but will not grow with elemental sulphur or sulphides as the source of sulphur.

By the use of mineral media of appropriate pH and sulphur source, and by making tenfold dilutions of samples of the extract from corrosion products, it is possible to obtain an approximate count of the numbers present of each of the three groups of bacteria associated with the corrosion process. Such counts performed on corrosion products of varying pH are shown in the table.

Sample of corrosion product	pH of sample	Dilution of sample to show growth		
		Th. concretivorus	*Th. thioparus*-like group	Miscellaneous group
A	9·88	Nil	10^3	10^6
B	7·52	Nil	10^6	10^6
C	5·77	Nil	10^6	10^5
D	4·03	10^5	10^1	10^1
E	3·42	10^6	Nil	Nil
F	2·18	10^6	Nil	Nil

Each of the three groups predominates at different stages of the corrosion process, the miscellaneous group of facultative autotrophs in the initial stage (pH 11–9), the *Th. thioparus*-like species between pH 9 and pH 5, while *Th. concretivorus* alone is present during the final stage of free acid formation below pH 5.

Evidence concerning the formation of intermediate products has been obtained by the exposure of sterile material to a hydrogen sulphide atmosphere. It has been found that on sterile fresh concrete small amounts of thiosulphate and polythionate are formed, while elemental sulphur is produced on sterile samples of the acidic end-products of corrosion. The whole corrosion process may, therefore, be explained as follows: the exposed walls of new concrete sewers with an initial pH of 11–12, on exposure to an atmosphere containing hydrogen sulphide, are subject to a twofold chemical change. Normal carbonation lowers the pH to 8·4 (the pH of the carbonate–bicarbonate–carbon dioxide equilibrium), and fixation of hydrogen sulphide as thiosulphuric and polythionic acids further lowers the pH to about 7·5.

While these purely chemical changes are taking place, there first occurs bacterial proliferation of the miscellaneous group of slow thiosulphate oxidizers. The oxidation by this group of the sulphur acids formed chemically does little to assist the drop in pH and may actually retard it. As the pH drops below 9, the *Th. thioparus*-like group then multiply, and their oxidation of thiosulphate and polythionate to sulphur and sulphuric acid results in a rapid drop in pH. This continues until the pH falls below 5, when *Th. concretivorus*, first by oxidation of sulphur formed by the *Th. thioparus*-like group and later by oxidation of the sulphur formed chemically, produces high concentrations (1–5 per cent) of free sulphuric acid, and so brings about the final products of corrosion typical of the process.

The early stage prior to the development of the *Th. thioparus*-like group is the slowest, and the corrosion increases in rate with the proliferation, first of the *Th. thioparus*-like group and then the *Th. concretivorus* group.

While the primary corrosive agent is hydrogen sulphide, none of the groups of bacteria concerned can utilize sulphides directly for growth. It is through the intermediate production of thiosulphates, polythionates and sulphur, by chemical means, that the corrosion process proceeds.

The detailed description of these bacteria and their function will be dealt with elsewhere.

I wish to thank Mr. E. F. Borie, the chief engineer of sewerage, Melbourne and Metropolitan Board of Works, for permission to publish this communication.

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A Sensitive 'Cartesian Diver' Balance

IN experimental cell physiology, the main difficulty often is how to obtain a reliable measure of the amount of protoplasm showing the biological (enzymatic, respiratory) activity studied. Dry weight[1] or nitrogen-content[2] of the whole object may be measured, but the measurement involves the death of the object. We use the 'reduced weight' of an object, namely, the buoyancy (usually negative) when suspended in water. The reduced weight of small objects was measured by Linderstrøm-Lang[3], but the cells were injured by the procedure. The present method permits the measurement of the reduced weight of small living objects, which are not damaged by the procedure and may thus be studied again and again.

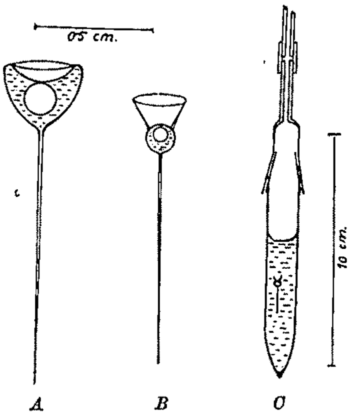
The principle of the balance is that of the Cartesian diver[4]. An air bubble (about 0·1 µl.) makes the balance float in water. The air bubble with some water is enclosed in a chamber which opens to the surroundings through a long narrow capillary, so that pressure variations in the flotation vessel are transmitted to the air bubble, while loss of air by diffusion is restricted.

The change in equilibrium pressure (p_x) due to charging the balance with an unknown weight (reduced weight = $R.W_x$) is compared with the change (p_{st}) resulting from the charging with some known weight (reduced weight = $R.W_{st}$). $R.W_x$ is calculated from the equation

$$R.W_x = R.W_{st}\,\frac{1-\dfrac{B}{B-p_x}}{1-\dfrac{B}{B-p_{st}}},$$

B being the normal barometric pressure. B, p_x and p_{st} are expressed in centimetres of water.

Larger balances of glass (Fig. A, air volume 0·5–1·0 µl.) could be blown when heating was carried out with a glowing platinum wire. However, the smaller balances (0·04–0·15 µl.) extensively used (B) always turned out too heavy when made entirely of glass; so the scale is made of polystyrene (sp. gr. 1·05). Polystyrene is dissolved in benzene, and the solution is blown so as to form a bladder, which is made to adhere to the glass of the diver balance. After evaporation of the benzene, the bladder hardens, so that it can be separated into two halves using a razor. The lower half adheres as a scale to the diver balance.



As standards for the weighings we use small gold weights the reduced weights of which are determined in the gradient tube[5]. In routine work with the balance, however, it has been found more convenient to use small polystyrene weights, which are more easy to handle with a pipette. The whole equipment for measurements with the balance is the same as that used in the work with the Cartesian diver microrespirometer[6]. The flotation vessel with the balance is shown at C.

The present method has been worked out for the accurate study of large amœbæ (*Chaos chaos* L.), the volume of which in most cases ranges from 0·01 to 0·1 µl., corresponding to reduced weights of about 0·2–2 γ. Since the error of the method in routine work is ± 0·02–0·03 γ, and with very small balances only ± 0·01 γ, this means that even very tiny objects can be studied with a fairly good accuracy. A complete weighing, including both the standard and the object under investigation, occupies ½–¾ hour. So far, the method has been used to study how reduced weight decreases with starvation in amœbæ.

This method has been worked out in the Carlsberg Laboratory, and a full account of the method as well as of the studies (with Dr. H. Holter) on *Chaos chaos* will appear in the *Compt. rend. Lab. Carlsberg, Sér. Chim.*

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Distribution of the Total and Acetic Acid-Soluble Phosphate in Soil Profiles having Naturally Free and Impeded Drainage

IN a reconnaissance soil survey of Aberdeenshire, a large and representative collection of soil profiles from a variety of geological parent material types has been made. Pairs of profiles differing in their degree of natural drainage—freely drained, and poorly drained (gleyed) soils—have been taken from a large number of arable fields over a variety of geological areas. Each particular pair of profiles presumably has had the same manurial treatment.

In the routine chemical analysis of these profiles, the percentages of total and acetic-soluble phosphate have been determined, and several facts relating to the phosphate status of these pairs of profiles have appeared.

The freely drained arable profiles have a medium brown crumb-structured A horizon; yellow or yellow-orange, mellow B_1 horizon; greyish-yellow, very indurated and compact B_2 horizon, which merges into the C horizon or parent material. The poorly drained soils have a grey-brown or brownish-grey cloddy A horizon, relatively low in organic matter, on a grey and brown mottled, cloddy gley G horizon.

It has been found that, in arable soils, when a freely drained and a poorly drained soil from the same field are examined: (1) the total phosphate content of the A horizon of the freely drained soil is greater than that of the poorly drained, and that the trend down the profile of the total phosphate generally shows a gradual decrease to the C horizon; (2) the total phosphate content of the poorly drained soil is at its highest value in the A horizon and tends to be lowest beneath the A horizon at the top of the gley horizon; beneath this it gradually rises to the C horizon; (3) the total phosphate in the C horizon of the freely drained soil is generally slightly higher than in the C horizon of the poorly drained soil; (4) the acetic-soluble phosphate in the freely drained soil is usually highest in the indurated B_2 horizon, in which the free silica and sesquioxides are also high; (5) the acetic-soluble phosphate in the poorly drained soil is generally highest in the gley horizon, where the total phosphate is lowest; (6) the rise in the acetic-soluble phosphate in the B_2 horizon of the freely drained soils is not connected with a corresponding rise in the total phosphate content of this layer. The clay content and base-exchange capacity of the indurated horizon are lower than the horizons above and below it.

The content of organic matter in the freely drained soils decreases gradually down the profile, whereas in the poorly drained soils the *A* horizon tends to be lower than that of the freely drained and decreases sharply below this in the gley horizon. The *p*H of the poorly drained soils is generally somewhat higher than that of the freely drained soils. The silica sesquioxide ratios down the poorly drained profiles fluctuate in an erratic manner and alternate with a periodicity from high to low. It is suggested that it is due to the periodicity in fluctuation of the level of the ground-water of these soils.

The high total phosphate in the *A* horizon of the freely drained soil as compared with the parent material suggests that applied phosphate may be accumulated more readily in the unavailable form in the naturally freely drained soils.

The striking reduction in the amount of the total phosphate and the high, readily soluble phosphate in the *G* horizons of the poorly drained soils is possibly related to the reducing conditions. This points to a loss of phosphate in the ground-water from these soils.

These several trends in the phosphate status of soils of different drainage conditions are being investigated.

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Vernalization of Sugar Beet

In connexion with L. G. G. Warne's experiments on the vernalization of lettuce reported recently[1], we are able to confirm that the vernalization treatment given after radicle emergence had occurred has no effect on the bolting of sugar beets.

Field experiments were carried out last year near Tirlemont (Belgium) with 'Hilleshög' beets. Several sets of seeds were soaked for seventy-two hours, according to E. Larose and R. Vanderwalle[2], by which time germination had begun and radicles emerged here and there. After soaking, seven sets (III to IX) were held at 2–3° C. during periods varying from ten to seventy days. Two control sets (I and II) were not given the low-temperature treatment; (I) seeds were not soaked, (II) seeds were soaked during seventy-two hours. The nine sets were sown in the open on April 16 (six repetitions of two hundred beets for each set).

Compared with the control sets, the thirty to seventy days vernalized seeds emerged from the soil later, and the growth of the seedlings was seriously delayed during the first six weeks; the differences grew less apparent in June, and after the middle of July all the sets were showing the same development. The beets were harvested on October 24. As appears in the accompanying table, practically no bolting occurred, but there were many missing beets among the fifty, sixty and seventy days vernalized sets. Moreover, the low-temperature treatment showed no effect on the yield of the crop.

These observations confirm Dr. Warne's opinion as to the possibility of avoiding the undesirable influence of natural vernalization on sugar beets and other crop plants by the sowing of already germinated seeds. Further experiments would, of course, be necessary to determine, for each plant, the appropriate soaking conditions of the seeds and the timing of the vernalization treatments.

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	Treatment	% missing beets	Bolters %	Roots		Sugar		Sugar		Leaves	
				Kgm.-ha.	±*e*	%	±*e*	Kgm.-ha.	±*e*	Kgm.-ha.	±*e*
1	Control	5	0	48,143	457	18·42	0·07	8872	103	38,420	1065
2	Soaked	5·5	0	49,011	488	18·56	0·10	9102	133	42,365	1100
3	Soaked, 10 days vernal.	5	0·08	47,320	493	18·67	0·10	8838	125	40,459	1407
4	,, 20 ,, ,,	4·6	0	48,573	228	18·53	0·06	9002	51	42,562	685
5	,, 30 ,, ,,	5·8	0	48,385	549	18·75	0·06	9072	96	41,887	855
6	,, 40 ,, ,,	5·1	0	48,067	291	18·53	0·06	8908	66	42,421	1217
7	,, 50 ,, ,,	13·7	0	46,218	482	18·47	0·11	8539	113	38,647	1312
8	,, 60 ,, ,,	15·2	0·10	46,195	810	18·37	0·07	8491	165	40,836	1179
9	,, 70 ,, ,,	9·2	0·18	47,893	465	18·55	0·09	8891	112	41,138	713

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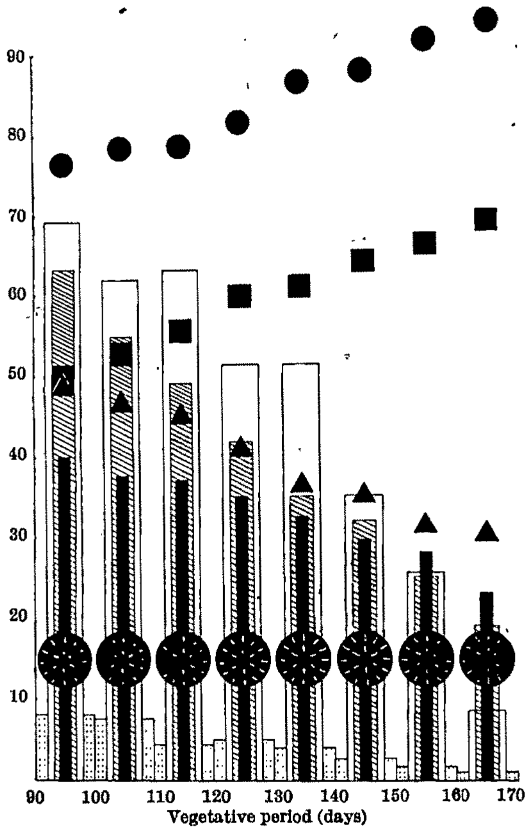
Correlation between Yield of Wheat and Temperature during Ripening of Grain

During the last five years investigations have been undertaken at this Institute for evolving a reliable method for obtaining varieties of wheat best suited to 'dry' as well as irrigated tracts, and also for determining their drought resistance. To achieve this purpose, a large number of exotic and Indian varieties of wheat (260 in all) have been grown on dry and irrigated plots of well-manured land at Delhi, Karnal and Pusa. The Indian varieties used in these experiments were representative of the important wheat-growing tracts of this country with their vegetative period ranging from 90 to 130 days, while the exotic varieties with a range of 90–170 days were representative of the important wheat belts of Canada, the U.S.S.R., Great Britain, Australia and other countries. All these varieties form a part of the large collection of wheat varieties maintained at this Institute.

Growth and harvest data, together with the dates of flowering and ripening of grain, were recorded. As the results appear to have some practical value, a brief preliminary report of the work is given here. It is intended to publish the full details of the work elsewhere. Some of the results are summarized in the accompanying diagram.



EFFECT OF TEMPERATURE ON YIELD OF WHEAT

☐, grain wt. per 10 plants (gm.)
■, 1,000-grain wt. (gm.)
●, mean max. temp. of ripening period
■, „ min. „ „ „ „
▲, „ per cent humidity „
Hatched area, ripening period (days)
Dotted area (ear/tiller) × 10

The full range of the vegetative period is divided into eight classes with a class interval of ten days. The values of grain yield, ripening period, 1,000-kernel weight as well as ear/tiller ratio for each class have been derived by taking the mean of corresponding values for all varieties falling within a class. It will appear that there is a progressive fall in grain yield and 1,000-kernel weight from the early flowering varieties to the late flowering ones. The fall is especially noticeable in the last three classes. Varieties in late-flowering classes require fewer days for grain ripening compared to those in the early ones. Number of ears per plant does not increase in late varieties in spite of heavy tillering, and consequently ear/tiller ratio declines with lateness in flowering. Mean maximum and minimum temperatures as well as mean per cent humidity for each variety were calculated by summing up all the values of the respective climatic factor during the ripening period and dividing by the number of days of the ripening period. Means of all such values for varieties falling within a class have been entered in the diagram. The plumpness of the grain in different classes is indicated in the diagram on the black circular areas.

Total as well as partial correlation coefficients are all very highly significant, with the exception of one case where the partial correlation coefficient $r_{bc.a}$ is non-significant. It is worthy of note that the general trend of results remains the same for dry as well as irrigated crops. This indicates that there is a more pronounced effect of atmospheric drought at least during the ripening period, and that even if the level of moisture in the soil is raised by a late irrigation, its effect on the yield is relatively smaller than that of the adverse climatic factor, namely, the temperature prevailing during the ripening period. This is further supported by the study of indices of resistance to soil and atmospheric drought which are summarized in Table 2.

TABLE 1. TOTAL AND PARTIAL CORRELATION COEFFICIENTS SHOWING RELATIONSHIP BETWEEN (*a*) GRAIN YIELD, (*b*) 1,000-KERNEL WEIGHT, AND (*c*) MEAN MAXIMUM TEMPERATURE OF THE RIPENING PERIOD. *S* = significant at 1 per cent point; *s* = significant at 5 per cent point; *n* = not significant

Nature of crop	Total correlation coefficient	Partial correlation coefficient	Observed value of *t*
Irrigated	r_{ac} = −0·83 to −0·70 r_{ab} = 0·87 to 0·68 r_{bc} = −0·83 to −0·44	$r_{ac.b}$ = −0·60 to −0·27 $r_{ab.c}$ = 0·58 to 0·56 $r_{bc.a}$ = −0·47 to −0·07*n*	39–7 *S* 87–19 *S* 26–0·6 *S*
'Dry'	r_{ac} = −0·81 to −0·68 r_{ab} = 0·88 to 0·64 r_{bc} = −0·89 to −0·54	$r_{ab.c}$ $r_{ac.b}$ = −0·51 to −0·15*s* $r_{ab.c}$ = 0·60 to 0·45 $r_{bc.a}$ = −0·62 to −0·18	32–2 *S* 38–10 *S* 40–3 *S*

TABLE 2. RESISTANCE INDICES

Vegetative period (days)	100	110	120	130	140	150	160	170
Index of resistance to:								
Soil drought	0·56	0·45	0·60	0·56	0·47	0·45	0·47	0·53
Atmospheric drought	1·00	0·94	0·94	0·75	0·67	0·48	0·39	0·16

The index of resistance to soil drought was calculated by dividing the yield of a variety grown on dry land by the corresponding yield of the same variety grown on irrigated land in the same year and in the same locality. This index does not show any significant difference in different flowering classes. The index for resistance to atmospheric drought, on the other hand, which is obtained by dividing individual yields of varieties in each class by the mean yield of the earliest class, shows a progressive decline with lateness in flowering.

Although yield in wheat and other cereals has been correlated with different growth characters, such as 1,000-kernel weight, plumpness, weight of grain per spike, time of flowering, etc.[1,2,4,5,7,9], there is very little experimental evidence to show the effect of temperature on yield. So far as I am aware, Waldron[8] is the only one who has found experimentally a high negative correlation between yield of wheat varieties and the mean maximum temperature of July. It has recently been shown in this laboratory[6] that high temperature during the ripening period of late varieties accelerates the rate of cell division in the developing grain. In late varieties the rate of loss of water from the developing grain is also considerably greater. This shortening of the ripening period appears to be detrimental to processes involved in grain filling, as demonstrated by the progressively falling 1,000-kernel weight and the shrivelled nature of grain resulting in low yield.

This work is an experimental confirmation of the observation, made by Howard[3], that in India early wheats possess an advantage in yield over late ones by virtue of their capacity to avoid high temperatures. It also places the empirical method of selecting wheat varieties so far practised in India on a scientific basis, showing that the selection should be on the correlation of yield and temperature during the ripening period.

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Dec. 31.

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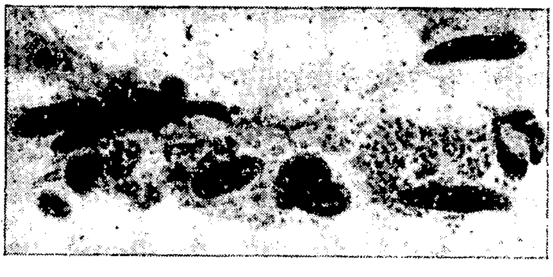
A Hæmosporidian of Bats

DURING the autumn of 1946 a number of bats belonging to ten species were examined for malaria parasites. These included: 39 *Rhinolophus ferrum-equinum*, 18 *Rhinopoma microphyllum*, 5 *Asellia tridens*, 13 *Taphozous nudiventris*, 57 *Myotis myotis*, 18 *Myotis daubentonii*, 17 *Myotis nattererii*, 78 *Pipistrellus kuhlii*, 45 *Miniopterus schreibersii* and 9 *Roussettus ægyptiacus*.

In 10 *Myotis myotis*, 3 *Myotis nattererii* and 35 *Miniopterus schreibersii*, red cells were found to harbour pigmented parasites. All the forms seen were diagnosed as gametocytes in various stages of development. The fully developed gametocyte is round and fills the whole of the parasitized red cell. The rate of infestation varied between single gametocytes in a thick drop up to two or three gametocytes per microscopic field in a thin film. Exflagellation of the microgametocyte was obtained in the wet chamber.

So far, no schizogonic cycle has been found in red blood cells even in splenectomized animals.



SMEAR OF BONE-MARROW FROM *Myotis myotis*

In one *Myotis myotis* intense schizogony was seen in smears of various tissues. Reticulum cells and cells of the granulocyte series of the bone-marrow contained numerous parasites in various stages of schizogony; in tissue smears free schizonts were also found. Wandering and fixed macrophages of the lung, kidney and liver were parasitized to a lesser degree. In one *Myotis nattererii* similar schizogonic forms were also found free in smears of the liver and kidney.

The schizogonic cycle in the tissues resembles in many respects that of *Hæmoproteus columbæ* as described by Aragão.

Myotis myotis, *Myotis nattererii* and *Miniopterus schreibersii* were heavily infested with pupiparous flies of the family Nycteribiidæ belonging to various species not yet fully identified. In one of these, sporozoites were found in the salivary glands.

Investigations up to now do not warrant any final conclusion as to the exact systematic position of these parasites. So far as we know, this is the first instance in which prolific extra-erythrocytic schizogony of a Hæmosporidian with a pigment-producing gametocyte has been found in a mammal.

Fuller details on the evolution of these parasites will be published elsewhere.

This work was carried out with a grant from the Wellcome Research Foundation. We are indebted to Dr. M. Dor for the identification of the bats.

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A Sandfly Described in 1691

WE have discovered recently the existence of a description of a sandfly by Phillipo Bonanni[1] published in 1691, together with an interesting plate. So far as we are aware, there is no mention of it in recent literature, and it is unknown to other workers on *Phlebotomus*.

Larrouse[2], in his treatise published in 1921, gives the earliest description of a *Phlebotomus* known to him then as being that of Scopoli[3] in 1786, and since Larrouse's monograph no earlier record seems to have been mentioned. Bonanni's description is of a general character, and he considers his sandfly to be a species of mosquito, which he calls *Sarapico*: "Culex minimus aculeatus Sarapico". He distinctly mentions its nocturnal and blood-sucking habits: "Avidissimus humani sanguinis noctu præcipuse venatur sine sono", and appears to be surprised at the ferocity of the bite which this minute creature is capable of with its short proboscis.

We have not verified its systematic position as yet, but hope to attempt to do so in the near future. As there is no figure of the buccal armature and genital organs, and also on account of recently accepted taxonomic characters, it will prove difficult to relate it to one of the recently described species.

It should be mentioned that Bonanni directs attention to another insect which was sometimes captured together with his sandflies. It appears from the description and figure to be a species of *Pericoma*, a genus closely allied to *Phlebotomus*.

A detailed communication is to appear elsewhere.

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QUANTITATIVE CHROMATOGRAPHIC SEPARATIONS OF SYNTHETIC PEPTIDES

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THE following chromatographic separations of simple peptides have been reported in the last few years: fractionation of arginyl peptides on acid earths[1], partition chromatography of acetyl peptides on columns of silica gel[2], partition of free peptides on columns of starch[3], partition on two-dimensional paper chromatograms of a partial hydrolysate of gramicidin *S* [4] and of peptides of urine[5], and separations of synthetic peptides on columns of carbon by displacement analysis[6].

We now wish to report some simple chromatographic methods capable of separating quantitatively and specifically a complex mixture of peptides and amino-acids into different groups; the separation of each group into its constituents can be realized by paper chromatography or otherwise.

Adsorption of Neutral Peptides on Acid Alumina in 10 per cent Formaldehyde[7,12]

The following table contains the measurements of Dunn and Loshakoff[8] of the apparent acid dissociation constant (*p*K*a'*) of neutral amino-acids and peptides in water and 9 per cent formaldehyde.

TABLE 1

Amino-acid	*p*K*a'* Water	*p*K*a'* 9% Formaldehyde	Peptide	*p*K*a'* Water	*p*K*a'* 9% Formaldehyde
Alanine	9·68	6·96	Glycyl-glycine	8·13	4·27
Valine	9·64	7·47	Di-glycyl-glycine	8·0	4·24
Norleucine	9·77	7·10	Glycyl-leucine	—	4·40
Phenylalanine	9·12	6·80	Alanyl-glycine	7·75	5·52
Glycine	9·60	5·92	Leucyl-glycine	—	5·57
Serine	9·15	5·63	Leucyl-tyrosine	—	5·07

Schramm and Primosigh[9] utilized the more acid *p*K*a'* of glycine and serine in 10 per cent formaldehyde to separate them from the other neutral amino-acids; glycine and serine are quantitatively adsorbed on acid alumina (Wieland[10]) and were eluted with alkali. Later they showed that threonine and cysteine are also adsorbed on alumina in 10 per cent formaldehyde[11].

We have applied the same principle to neutral peptides and found that they are all quantitatively adsorbed on acid alumina; they may be eluted quantitatively by hot water which dissociates the peptide-formaldehyde complex. β-Alanine, which has an —NH_2 group on a primary carbon like glycine, is also adsorbed quantitatively on acid alumina and may so be separated from α-alanine. Table 2 shows the results of some separations of binary mixtures of amino-acids and peptides.

TABLE 2. SEPARATIONS OF BINARY MIXTURES OF AMINO-ACIDS AND PEPTIDES IN 10 PER CENT FORMALDEHYDE

Non-adsorbed amino-acids	% in filtrate (i)	% in filtrate (ii)	Adsorbed substances	% in eluate (i)	% in eluate (ii)
Alanine	99·4		Alanyl-phenylalanine	101·3	100
Alanine	99		Leucyl-glycine	100·5	
Alanine	100	96·4	*β*-Alanine	99·2	
Leucine	100	101·6	Glycyl-leucine	99	
Leucine	100·7		Leucyl-tyrosine	101·2	
Tyrosine	99·2	99	Alanyl-glycine	101·5	
Tryptophane	98		Alanyl-glycine	100·5	

(i), Nitrogen determinations by micro-Kjeldahl; (ii), determinations by known specific methods.

10 gm. of acid alumina[10] are washed in a column of 10 mm. diameter with 300 ml. of water; the *p*H of the last drop of effluent must be about 4·8–4·9 or else separations are not quantitative. After filtering on the column the solution of about 10 mgm. of the mixture of substances in 5 ml. of 10 per cent formaldehyde (*p*H 8·5), one washes the amino-acids into the filtrate with 50 ml. of 10 per cent formaldehyde (*p*H 8·5). Elution of the peptides is obtained by washing the column with 100 ml. of hot water (∼90°).

Adsorption of Glycyl-peptides on Acid Alumina in 1 per cent Formaldehyde[12]

Table 1 shows that glycyl-peptides ($H_2N–CH_2–CONH–CH$*R*$–COOH$) have a more acid *p*K*a'* in 9 per cent formaldehyde than other (alanyl-, leucyl-, etc.) peptides. We have found that in 1 per cent formaldehyde glycyl-peptides are already sufficiently acid to be adsorbed quantitatively on acid alumina, whereas other peptides pass through the column, not being adsorbed. Elution of the glycyl-peptides is easily obtained by washing the column with hot water. The amino-acids glycine, serine, threonine, cysteine and β-alanine, which are adsorbed from 10 per cent formaldehyde solution, are not adsorbed from 1 per cent formaldehyde solution. Table 3 shows some separations of binary mixtures.

TABLE 3. SEPARATIONS OF BINARY MIXTURES OF AMINO-ACIDS AND PEPTIDES IN 1 PER CENT FORMALDEHYDE

Non-adsorbed substance	% in filtrate (i)	% in filtrate (ii)	Adsorbed peptide	% in eluate (i)	% in eluate (ii)
Alanyl-leucine	102		Glycyl-leucine	98·3	99·2
Alanyl-leucine	100		Glycyl-tryptophane	98	100
Leucyl-glycine	100·7		Glycyl-leucine	98·6	
Leucyl-glycine	100		Glycyl-tryptophane	100·5	
Glycocolle	99·6	103	Glycyl-glycine	101·3	
Serine	97·6		Glycyl-tyrosine	100	93

(i), Nitrogen determinations by micro-Kjeldahl; (ii), specific determinations by known methods.

The optimum *p*H for separations in 1 per cent formaldehyde is 3·5 for effluent wash-water; acid alumina prepared according to Wieland[10] can be utilized as it is; the mixture of peptides (10–20 mgm.) dissolved in 5 ml. 1 per cent formaldehyde (*p*H 3·5) is poured on a column of 5 gm. acid alumina (10 mm. diameter); by washing with 50 ml. of 1 per cent formaldehyde, *p*H 3·5, the non-adsorbed substances are washed into the filtrate. Elution of adsorbed glycyl-peptides is obtained with 100 ml. hot water (∼90°).

We suppose that seryl-, threonyl-, cysteyl- and β-alanyl-peptides will behave like the glycyl-peptides.

Adsorption of Aromatic Neutral Peptides on Carbon

Wachtel and Cassidy[13], Tiselius[6], Schramm and Primosigh[9] have studied adsorption of amino-acids on carbon columns, and have observed that the aromatic amino-acids (phenylalanine, tyrosine, tryptophane) are firmly bound. Elution of the adsorbed amino-acids is often difficult and seldom exceeds 85 per cent.

We have found that carbon columns retain quantitatively neutral peptides containing aromatic amino-acids; other neutral peptides containing only aliphatic amino-acids are not adsorbed. Elution is possible with water saturated with ethyl acetate[6,13]; yields attain 95 per cent if the carbon ('Activit *50XP*' [14]) is first purified by boiling in 20 per cent acetic acid and then treated with ephedrin[6]. 1 gm. of 'Activit' can adsorb about 30–50 mgm. of aromatic dipeptides. Table 4 shows some typical separations.

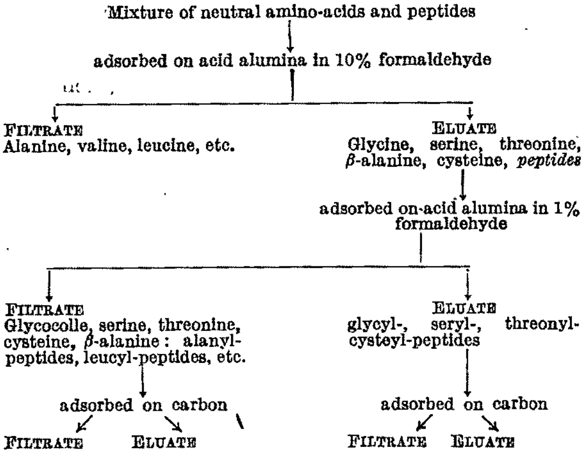
TABLE 4. SEPARATIONS OF BINARY MIXTURES OF ALIPHATIC AND AROMATIC PEPTIDES ON CARBON

Non-adsorbed aliphatic peptides	% in filtrate (i)	Adsorbed aromatic peptides	% in eluate (i)	(ii)
Leucyl-glycine	100·8	Leucyl-tyrosine	96·8	100
Glycyl-leucine	98·3	Glycyl-tyrosine	99·8	100
Alanyl-glycine	99·8	Alanyl-phenylalanine	100·4	99·1

(i), Nitrogen determinations by micro-Kjeldahl; (ii), specific determinations by known colorimetric methods.

0·5 gm. of '*Activit 5OXP*' is boiled for 5 min. with 4 ml. of 20 per cent acetic acid, filtered, washed with 15ml. hot water, then treated in a beaker with 10 ml. water containing 2 mgm. of ephedrine; after shaking for 10 min. the carbon is poured into the column (10 mm. diameter) and washed with 15 ml. water saturated with hydrogen sulphide. The mixture to be separated (20–30 mgm.) in 5 ml. of 5 per cent acetic acid saturated with hydrogen sulphide is filtered on the column, which is then washed with 25 ml. of 5 per cent acetic acid saturated with hydrogen sulphide. Non-adsorbed substances are thus washed into the filtrate. The aromatic peptides are eluted with 125 ml. of water saturated with ethyl acetate and hydrogen sulphide.

By the methods described above a complex mixture of neutral amino-acids and peptides, such as may result from partial hydrolysis of a protein, can be separated into different groups as shown in the following scheme:


Mixture of neutral amino-acids and peptides
adsorbed on acid alumina in 10% formaldehyde
FILTRATE
Alanine, valine, leucine, etc.
ELUATE
Glycine, serine, threonine, β-alanine, cysteine, *peptides*
adsorbed on acid alumina in 1% formaldehyde
FILTRATE
Glycocolle, serine, threonine, cysteine, β-alanine: alanyl-peptides, leucyl-peptides, etc.
ELUATE
glycyl-, seryl-, threonyl-cysteyl-peptides
adsorbed on carbon
FILTRATE
Aliphatic peptides
Example:
Alanyl-glycine
ELUATE
Aromatic peptides
Alanyl-phenylalanine
adsorbed on carbon
FILTRATE
Aliphatic peptides
Glycyl-alanine
ELUATE
Aromatic peptides
Glycyl-phenylalanine

Adsorption of Acid Peptides on Acid Alumina

Preliminary experiments with glutathione and glycyl-glutamic acid show that acid peptides are quantitatively adsorbed on acid alumina, like glutamic and aspartic acid; elution can be obtained either by acid or, better, by alkali.

All these experiments were done with synthetic di- and tri-peptides; there are reasons to believe that the same methods will be applicable to higher peptides.

Acknowledgments are due to Prof. Cl. Fromageot for his interest in this work, to Dr. H. Pénau (UCLAF, Paris) for a research fellowship granted to one of us (M. J.), and to Prof. V. Prelog (Zurich), Dr. M. Guggenheim (Basle), and Dr. C. J. Cavallito (Rensselaer, New York), for various synthetic peptides.

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THE TEACHING OF TAXONOMY

A JOINT meeting of the Linnean Society and the Systematics Association was held in the rooms of the former at Burlington House on February 6, when "The Teaching of Taxonomy" was the subject discussed. Sir Clive Forster-Cooper opened the discussion by noting the wide points of view and urging the importance of modern taxonomy. At one time taxonomy was the foremost branch of biology. It then suffered a decline relative to newer aspects and for a long time was considered a blind alley; but a revival of interest is now occurring. There are dangers in speaking too much of the 'professional' taxonomist, but the museum taxonomist is certainly overburdened in the answering of questions for others and has very little time left for research. It becomes a question whether all the wealth of facts and ideas now tending to be incorporated in taxonomy can be brought together in a unified syllabus for teaching in schools and universities. Sir Clive made the suggestion that the Systematics Association should appoint a committee to draw up some sort of guiding rules, of a sufficiently elastic nature, for the benefit of teachers, and to encourage them to teach students taxonomy along desirable lines.

Prof. James Gray considered it would be a pity if taxonomists should look upon their subject as a Cinderella, for though taxonomy is not the sole basis of biology it can play its part like all other branches in the development of the subject. Taxonomy must be seen as one of many points of view. Not more than 10 per cent of students of biology become taxonomists, and the problem for the teacher is how he can convey the taxonomic point of view and the discipline of the subject to the other 90 per cent so that they can carry away something which is to them a matter of intellectual pride. The systematist is to a large degree born such, and works much by general impressions. On the whole, the botanist seems to be more fortunate than the zoologist in having workable keys provided for him, and there is a great need in zoology for simple keys that can be used by students and teachers.

Dr. W. B. Turrill urged that plant taxonomy should be taught because it is indispensable to the proper study of every other branch of botany, provides admirable material for training in observation, concentration, and record keeping; it is the best means by which students can become familiar with the great wealth of form and the extent of combinations and permutations of characters. Much of the time of professional taxonomists would be saved if more botanists were able to carry out a fair proportion of their own determinations and knew when, and when not, to call in the specialist. That taxonomy is not kept to the forefront in schools and colleges may be because it is a subject in which the teacher can be too easily caught out by his students. Dr. Turrill argued that the best way of giving instruction in taxonomy is by practice with material collected by the student himself. Actual practice in the use and making of keys, descriptions, and illustrations has the double advantage of establishing and increasing interest and in laying a solid foundation for discussion on the principles of classification. When the student is acquainted with sufficient factual data he should be helped to grasp the total of underlying principles and generalizations, and aided in giving them logical form. Through the whole of their course students should be made to go out into the field and garden to collect, handle, dissect, and record their findings for actual specimens which they must learn to classify and dissect. In brief, there are decided limits to the possibilities of the direct adequate teaching of taxonomy, but the student can and should be taught to teach himself taxonomy.

Prof. A. R. Clapham pointed out that plant taxonomy is a branch of botany in its own right and is also a tool for other branches. Yet botany has a unity imposed by its materials. The teacher has to aim at training botanists, and all his students should know something of the methods and principles of taxonomy just as those who become taxonomists should know at least a minimum of facts and principles in other branches. Taxonomy is not every man's meat. There must be the right mental outlook and a good appreciation of formal characters and of resemblances and differences, that is, a good visual memory. At the University of Sheffield, Prof. Clapham has no course planned solely for taxonomy, but the subject is united with other subjects such as floral biology, cytogenetics, or ecology. Emphasis is placed on the study of species, and examples are taken from the British flora. Small problems are set which may involve taxonomic studies. Taxonomy as a working tool is taught in the field by the study of quadrats and transects. Every year there are one or two students who are much more competent in taxonomy than are other students. These are encouraged to concentrate on the subject. The highest standards are insisted upon.

Prof. H. Boschma (University of Leyden) was introduced by Prof. de Beer as holding the unique position of professor of taxonomic zoology. Prof. Boschma replied to Prof. Gray that the latter's suggestion that identification of plants is easier than that of animals is not true for all groups in either kingdom. He gave some interesting details of the courses in zoology in Leyden. There are two main examinations. In preparation for the first, systematics is taught in association with anatomy; but for the second examination a special subject is chosen, and only a small percentage of students take systematic zoology. The special student is given material on which to work, is introduced to relevant literature, and then has very largely to investigate for himself. The successful students are the born systematists, and sufficient are selected to fill the vacant posts in museums and other institutions needing specialist taxonomists.

Dr. P. Richards thought that the reputation of taxonomy as a dull subject is due partly to an attempt to teach the results of taxonomy rather than taxonomy as a living branch of research, and partly to academic teaching being too much concerned with the families and larger taxonomic units rather than with species and intra-specific units. The characters of, for example, a family are extremely abstract. He described an experiment tried recently at Cambridge in which every advanced student makes, with some help and guidance, a thorough study of the taxonomy of a single variable species or of two or three closely related species, in the field, the laboratory, and the herbarium. The results have shown that the method is very successful in stimulating interest and in giving insight into the real nature of taxonomy. Dr. Richards also suggested that the teaching of taxonomic botany should not be based entirely on the flowering plants. In particular, mosses and liverworts provide excellent material, available at any time of the year, for the teaching of taxonomy. He also urged the need for a text-book of plant taxonomy covering the whole field. He suggested that the Systematics Association should initiate or encourage the writing of such a book.

Prof. A. E. Trueman referred to the point of view of the palæontologist and to the great difficulties of identification owing to the very great wealth of past life now known. More and more species and genera are having to be accepted. Whether it be studied for applied purposes or as part of the philosophy of biology, all kinds of taxonomic research and training are involved in palæontology.

Prof. A. G. Tansley agreed that a systematist must be born and endowed with a good visual memory. He stressed the importance of students working at individual species rather than being given abstract accounts of families. A student cannot build up a sound taxonomic knowledge unless he gets to know species in the field and herbarium.

Dr. S. P. Wiltshire stressed the need in plant pathology for training in the procedure of identification of fungi. The correct identification of pathogenic fungi is essential in order to make the relevant literature available. Yet many supposedly fully trained mycologists from the universities have never seen the inside of a herbarium packet or looked at the rules of nomenclature.

Mr. A. J. Wilmott said that by the study of one particular example of name change, if sufficiently complicated, all sorts of methods and bases of systematic work can be understood.

Dr. G. S. Carter considered that biology is now part of the schoolboy's *work* and has, therefore, less interest for him. Students should be encouraged to take up the problems of classification of small groups. This would make them realize what a species is.

Prof. I. Manton pointed out that many provincial teaching institutions have no great national collection of plants near at hand. She suggested that the Systematics Association might well arrange a course for precise training in herbarium methods.

Dr. O. W. Richards asked that universities should employ entomologists on their staffs and have entomology recognized as a degree subject.

The president of the Linnean Society, Prof. G. R. de Beer, in summing up the results of the discussion, gave examples of the high cost of a lack of knowledge of taxonomy. It had been clearly shown that there is a wide recognition of the value of taxonomy and that more of it is wanted. When the Linnean Society was founded, taxonomy was the most prominent aspect of biology, and ever since, symposia on taxonomic subjects have been a recurring feature of its meetings. This shows the perennial value of taxonomy as an intellectual discipline. The Society itself is the custodian of important taxonomic collections, and the Council is fully prepared to co-operate in the giving of instruction in taxonomic principles.

FORTHCOMING EVENTS

Wednesday, April 9

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. H. Steiner: "Aromatics from Petroleum".

Thursday, April 10

INSTITUTION OF CHEMICAL ENGINEERS (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11 a.m.—Twenty-fifth Annual Meeting; at 12 noon—Mr. Hugh Griffiths: "Crystallisation".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. T. Melling: "Commercial Development of Electricity Supply as a Consumer Service".

ILLUMINATING ENGINEERING SOCIETY, MANCHESTER CENTRE (in the Reynolds Hall, College of Technology, Manchester), at 6 p.m.—Mr. W. J. Wellwood Ferguson: "Lighting in Coal Mines".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. C. E. Fielding: "A Review of Production Difficulties in Relation to Aircraft Design".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. N. H. Searby: "Television".

Wednesday, April 9—Thursday, April 10

FARADAY SOCIETY (in the Chemistry Department, The University, Manchester).—General Discussion on "Electrode Processes".

Wednesday, April 9

At 10 a.m.—General Discussion.

Thursday, April 10

At 10 a.m.—General Discussion.

INSTITUTION OF ELECTRONICS, N.W. ENGLAND SECTION (in the Great Hall, College of Technology, Manchester).—Annual General Meeting and Second Annual Exhibition.

Wednesday, April 9, at 6.30 p.m.
Thursday, April 10, at 2.30 p.m.

MATHEMATICAL ASSOCIATION (at the Polytechnic, 309 Regent Street, London, W.1).—Annual General Meeting.

Wednesday, April 9—Saturday, April 12

PHYSICAL SOCIETY (at Imperial College, Imperial Institute Road, London, S.W.7), at 10 a.m.—Thirty-first Exhibition of Scientific Instruments and Apparatus.

Thursday, April 10—Tuesday, April 15

BRITISH PSYCHOLOGICAL SOCIETY (at the Bergman Österberg Physical Training College, Dartford Heath, Kent).—Annual General Meeting.

Mr. R. J. Bartlett: "Mind" (Presidential Address), at 5 p.m. on April 12.

Friday, April 11

TEXTILE INSTITUTE—(at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. C. Garrett: "The Bleaching and Subsequent Dyeing of Jute Fabrics".

BIOCHEMICAL SOCIETY (at the Rowett Research Institute, Bucksburn, Aberdeen), at 2.30 p.m.—Scientific Papers and Demonstrations.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Annual General Meeting.

PAPER MAKERS' ASSOCIATION, NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Discussion on "From Press to Reel End".

SHEFFIELD METALLURGICAL ASSOCIATION, MODERN METHODS OF ANALYSIS GROUP (at 198 West Street, Sheffield), at 7 p.m.—Mr. G. Robinson: "Metallurgical Chromatography".

SOCIETY OF DYERS AND COLOURISTS (at St. Enoch Hotel, Glasgow), at 7 p.m.—Dr. G. L. Royer: "The Application of Microscopy to the Textile Field".

Saturday, April 12

BRITISH INTERPLANETARY SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 6 p.m.—Mr. Lionel Gilbert: "Cosmic Rays".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LABORATORY STEWARD (Grade D) IN THE DEPARTMENT OF BOTANY—The Professor of Botany, The University, Leeds 2 (April 8).

SCIENTIFIC OFFICER as ASSISTANT IN THE OPERATIONAL RESEARCH SECTION (University degree in Chemistry, Biology, Physics or Mathematics essential)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Operational Research Section' (April 12).

DIRECTOR OF THE SCIENCE DEPARTMENT—The Director, Appointments Department, British Council, 3 Hanover Street, London, W.1 (April 15).

SENIOR LECTURER, and a LECTURER, IN THE DEPARTMENT OF ANATOMY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (April 15).

LECTURER IN THE DEPARTMENT OF GEOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 24).

LECTURER with qualifications in Pure Mathematics, a LECTURER with qualifications in Applied Mathematics, and an ASSISTANT LECTURER with qualifications in Pure or Applied Mathematics—The Registrar, The University, Manchester 13 (April 24).

LECTURER (Grade III) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING (Electrotechnics)—The Registrar, The University, Liverpool (April 26).

CHIEF PHARMACIST to the Ministry of Health—The Director of Establishments, Ministry of Health, Whitehall, London, S.W.1 (April 26).

I.C.I. RESEARCH FELLOWSHIPS (3) IN CHEMISTRY or PHYSICS, or some allied subject such as Biochemistry, Colloid Science, Chemotherapy, Pharmacology, Metallurgy or Engineering—The Registrar, The University, Liverpool (April 30).

PROFESSOR OF PATHOLOGY in the Medical School, Dundee, and PATHOLOGIST and CLINICAL PATHOLOGIST to the Dundee Royal Infirmary (associated appointments)—The Secretary, The University, St. Andrews (April 30).

LECTURER IN MATHEMATICS, and a LECTURER IN MATHEMATICAL PHYSICS—The Secretary, Queen's University, Belfast (May 1).

TECHNICIAN in the Dental Hospital of the University of Bristol—The Professor of Pathology, Canynge Hall, Bristol 8 (May 1).

LECTURER IN SOCIAL PSYCHOLOGY—The Registrar, The University, Leeds 2 (May 1).

PROFESSOR OF METALLURGY—The Registrar, University College, Singleton Park, Swansea (May 3).

READERSHIP IN PURE MATHEMATICS tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 13).

LECTURER IN HUMAN PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (May 15).

METALLURGIST with industrial or research experience of foundry work, a METALLURGIST for independent research work on non-ferrous metal foundry problems, and METALLURGISTS (2) for the Liaison and Technical Service Department—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

LABORATORY STEWARD (biology)—The Head of the Department of Chemistry and Biology, The Polytechnic, 309 Regent Street, London, W.1.

ASSISTANT TECHNICAL SECRETARY IN THE METALLURGY DIVISION—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (endorsed 'Metallurgy Division').

ASSISTANT BIOCHEMIST at the Courtauld Institute—The Medical School Secretary, Middlesex Hospital, London, W.1.

LECTURER IN GEOGRAPHY, a LECTURER IN PURE MATHEMATICS, a LECTURER IN ORGANIC CHEMISTRY, a LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College, Leicester.

TECHNICAL RESEARCH ASSISTANT (well qualified) for nutritional research—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

SENIOR LECTURER IN MATHEMATICS—The Secretary, Royal Technical College, Glasgow.

RESEARCH CHEMIST—The Director of Research, Research Association of British Flour Millers; Cereals Research Station, Old London Road, St. Albans.

TECHNICAL INDEXER on the staff of the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

PHYSICIST with considerable knowledge of rubber technology, for research and development on the engineering applications of rubber, a PHYSICIST to work on fundamental aspects of rubber elasticity, a PHYSICAL CHEMIST to work on the kinetics of oxidation, and an ORGANIC CHEMIST to study the effect of structure on chemical reactivity—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

CHEMIST, a BOTANIST, and an AGRICULTURIST, in the Intelligence Section of the Plant and Animal Products Department—The Establishment Officer, Imperial Institute, South Kensington, London, S.W.7.

CHEMIST or BIOCHEMIST to assist in isolation of substances of biological interest from natural sources—The Professor of Pathology, Sir William Dunn School of Pathology, Oxford.

ANATOMY DISSECTING-ROOM ATTENDANT, and a LABORATORY STEWARD (experienced) with knowledge of physics and laboratory administration—The Secretary, King's College, Strand, London, W.C.2.

METEOROLOGICAL OFFICERS IN MALAYA—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

LABORATORY TECHNICIAN—The Medical Superintendent, St. Luke's Hospital, Middlesbrough.

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NATURE

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ATOMIC ENERGY

THE series of talks on atomic energy which the British Broadcasting Corporation arranged during the first week of March in the Home Service Programme and afterwards repeated in the Third Programme have rightly been characterized by Mr. J. B. Priestley as a fine, bold enterprise in public enlightenment. No man of science or thoughtful citizen who has any conception of the implications for mankind of recent discoveries in this field can fail to welcome this effort, and the B.B.C. is to be congratulated further in publishing so promptly in the *Listener* (March 13) the whole series of talks, so that they can be studied at leisure by listeners and also by those who were unable or disinclined to hear the whole series. Delivered by such authorities as Prof. J. D. Cockcroft, Prof. M. L. E. Oliphant, Sir George Thomson, Prof. P. M. S. Blackett, Sir Henry Dale and Sir John Anderson, who have been in one way or another closely associated with these developments, they put before the public quietly but frankly the facts, theories and problems of atomic energy and their main implications for good or ill.

The scientific worker will not expect to find in these talks facts that were not already well known to him. Prof. Cockcroft's account of early experiments, and Prof. Oliphant's description of planning in secret add little to what has already been told in the Smyth Report or the "Statements Relating to the Atomic Bomb". On the military side, Group-Captain G. L. Cheshire recorded his experiences in dropping the bomb, Dr. J. Bronowski described the deep impression made on him when assessing the damage done by the bomb at Hiroshima and Nagasaki, and Sir George Thomson's sombre analysis of the question "Is defence possible ?" is calculated to bring home further, if need be, the dire prospect if mankind allows such bombs to be used again.

Sir George Thomson was able to say little about the contents of the report of the Atomic Energy Commission now before the Security Council; but he and the other speakers said enough to show clearly how great are the obstacles to agreement, and how compelling is the purpose for establishing a strong and comprehensive international system of control and inspection. These talks well display the genuine concern of the scientific worker at the evil use being made of scientific discoveries and at the danger to the free communication of knowledge, in spite of the recommendation of the Atomic Energy Commission itself that safeguards on research in nuclear physics established by the international control agency should not interfere with the prosecution of scientific research or the publication of its results, provided no dangerous purpose or use is involved. Here, too, is well emphasized the way in which preparation for atomic war diverts from peaceful pursuits the resources of man-power and materials which might otherwise so greatly enrich the life of man. We can have atomic energy for peace or for war—but not for both : we can have freedom of science and the peaceful development of atomic energy, or we can have the slow strangling of science by the spread of secrecy and restriction on communication of knowledge in one field after another.

These are choices which mankind must make, deliberately or unconsciously. But there is an even sharper choice and contrast. These talks which the B.B.C. has, with so much public spirit and enterprise, promoted, leave no room for rash optimism that a system of control and inspection by itself will be adequate, however efficient. Inspection and control must be supported by a genuine and resolute will to peace, and a world-wide public opinion which understands what is at stake and is prepared for the sacrifices of national sovereignty which are demanded.

There is no sensationalism in these talks, nor pessimism either, even when Sir George Thomson expresses the opinion that the best defence, and that a poor one, is to evacuate the big cities from the start. The strategic significance of the atomic bomb is analysed by Prof. Cyril Falls, who develops the same idea of dispersal and suggests that, from the national point of view, the best defence is in the first instance ability to retaliate in kind, which still requires the support of traditional armed forces. Prof. Falls adds, however, that in his personal opinion he believes profoundly that the only sure hope for civilization lies in abolishing war altogether.

These opening talks alone should do much to dispel that unconcern with the problem and to quicken the sense of urgency, on the co-operative absence of which in Great Britain Prof. H. C. Urey commented during his recent visit. Even more marked becomes the justification for the whole series, when Prof. Blackett and Sir Henry Dale discuss peaceful uses of atomic energy. It is not Prof. Blackett's lucid discussion of the possibilities of atomic energy for primary power stations, or his suggestion that by 1970 a large proportion of the power in Great Britain will be obtained from atomic energy, that is so significant. It is rather his emphasis that the major difficulty in the realization of such hopes is neither technical nor scientific nor a matter of supply, but rather political and international. "If the major part of the scientific and technical effort available for atomic energy continues to be directed towards the production of more and better bombs, there will be insufficient technical effort and insufficient raw material available to allow the rapid development of industrial power." Even if the bombs are never used, the accumulation of stocks by the armed services of the Great Powers may well check decisively the exploitation of atomic energy for peaceful ends.

From a slightly different outlook, Sir Henry Dale drives home the same point when discussing the application of atomic energy for medicine and research. There is perhaps present in his mind still more the fear of every scientific worker, to which Prof. Oliphant referred in his talk, that the very success of the security restrictions and secrecy which surrounded the work on the development of the atomic bomb will surround the work of the man of science for evermore. Sir Henry asks, "Are men of science to be left to explore these great vistas of new and beneficent knowledge in medicine and elsewhere in peace ? Or will the perversion of these same great gifts of science, and others yet to come, to the wholesale destruction of human life and achievement, bring the civilization, which man has been building since before the dawn of history, crashing down into final ruin ?"

That this is the most important of all the questions facing mankind to-day is supported by Sir George Thomson's following talk on "International Control". Sir George testifies to the profound conviction of men of science, and especially those who played any part in preparing this weapon, of the need for action. However impersonal the scientific attitude may be, and whatever views one may take of the duties of a scientific worker in war, none of us who are physicists, said Sir George, has escaped the feeling of sick horror that what ten years ago seemed a triumph of intellect now adds a supreme danger to our badly shaken civilization. No one is more determined than the physicist that this danger should be turned to a blessing.

Before coming to an extremely lucid review of the work of the Atomic Energy Commission of the proposals known as the Baruch plan, Sir George points out that industrial and military uses are closely interlocked. No real security is achieved, he said, by destroying the bomb case and keeping the plutonium ; destroying the whole thing means destroying the very material most needed for industrial development, and material which must be made again if atomic energy is used at all. The difficulty about the Baruch proposals is that a really rigorous international inspection is essential. It is the only way, he said, in which nations can be convinced that their possible rivals are not secretly preparing weapons they have themselves promised not to prepare ; and that, knowing themselves to be honest, they will not suffer from the sharp practice of others in whom they, perhaps wrongly, have little confidence.

One of the great advantages of the Baruch Plan is that it allows scope for development work and, in fact, runs development work and inspection in double harness ; but when it seemed unlikely that the U.S.S.R. would accept any form of international inspection, the Scientific and Technical Committee was asked to report on the feasibility and the methods of control. This Committee stated definitely that there is nothing on the technical side to make control impossible, and when, while a further systematic study of methods of control was proceeding, the U.S.S.R. accepted, in principle, the idea of an international inspectorate the day-by-day working of which should not be subject to the action of the veto, the easing of the situation encouraged a feeling of optimism. Sir George hopes that the Atomic Energy Commission would be allowed to continue detailed work on the lines of its report to the Security Council of December 31, 1946, and he indicates a number of questions of the highest importance which have yet to be discussed which do not touch that of the veto.

This realistic talk brings home the difficulties with which international control is hedged, but was not too pessimistic, Sir George being convinced that mankind has too much to lose if agreement fails for him not to believe that some way round would be found. Bertrand Russell's talk on the outlook for mankind is perhaps the most sombre of the series. He painted a picture, sober but realistic, of the consequences of failure to reach agreement and of the outcome of atomic war; and he urged, like Sir George Thomson, the adoption of an international system of control of the use of atomic energy as an immense advance towards security. Such control would make possible the peaceful use of the new discoveries without the constant menace of atomic 'Pearl Harbours'; it would demonstrate the possibility of international co-operation and would represent the first step in that limitation of national sovereignty without which nothing can be achieved. Like Prof. Falls, he insists on the impossibility of isolating the question of atomic energy, and emphasized that the real problem is to prevent great wars, for once they have begun no previous agreement will prevent the use of the most terrible weapons available.

Lord Russell based his main appeal on this point and the imperative need for drastic limitation of national sovereignty. He urged that it is the duty of those who realize the implications of modern weapons to devote themselves to a campaign of enlightenment addressed to the peoples of the West and the governments of the East. If mankind can be brought, while there is yet time, to realize that the most elementary motives of self-preservation demand this revolutionary change as regards national sovereignty, he believes a new era of unprecedented happiness and prosperity will almost inevitably result. It is necessary to overcome ancient loyalties, prejudices and deep-rooted suspicions, and to learn to think of mankind as a whole.

Sir John Anderson, in the concluding talk on British interests, does not take quite so grave a view, but his able summing up of the whole series emphasizes once more the impossibility of isolating atomic bombs from other weapons of war. He points out that in the Washington Declaration of November 1945, President Truman, Mr. Attlee and the Prime Minister of Canada pledged themselves to work for the elimination from the armouries of the nations not merely of the atomic bomb but also of all weapons of mass destruction. Like Lord Russell, he stresses the fact that the international body suggested as a means of protecting the world against the military use of atomic energy and encouraging its peaceful use would be something entirely new in human experience.

The ultimate choice before mankind is between a richer and a healthier world, and the virtual extinction of civilized life as we know it. That the choice should thus be put so fairly and squarely before every citizen is no mean contribution to the formation of enlightened public opinion; for it is on such opinion that every democratic government must rely, if it is to frame and pursue a policy of peace and co-operation, with all their implications, which these broadcasts so clearly displayed.

ATOMIC SCIENTISTS' ASSOCIATION

In the United States, the scientific workers concerned in the investigation of nuclear fission in its application to the atomic bomb quickly banded together to make known their views on the scientific, social and international problems raised by the controlled release of atomic energy. In Britain, there were not so many with experience of the subject, and they were scattered up and down the country. Nevertheless, in the early summer of last year, the Atomic Scientists' Association came into being, with the main purpose of providing a forum for discussion of the subject.

In the recent series of broadcast talks on atomic energy, Sir George Thomson referred to the work which the Association is trying to do in Great Britain in impressing on public opinion generally, and on the Government in particular, the critical nature of the position. So far as scientific men themselves are concerned, there can be little question that they are awake to their social responsibilities in this matter, and endeavouring to induce their fellow citizens to consider realistically the new proposals and the departures from previous ideas and practice which the situation demands. That is indeed an encouraging feature of the situation. But the work and aims of the Atomic Scientists' Association deserve indeed to be much more widely known. They go far beyond the technical contributions the Association has already made to the development of an adequate plan of control, either for immediate action or for future operation.

Suggestions to these ends, such as are embodied in the Statement from the Council of Association printed in *Nature* earlier this year (**159**, 47; 1947) come with the greater weight of authority in that the full membership of the Association is limited to men of science with first-hand and specialized knowledge of atomic energy. The Association can thus speak as a body of experts, and this considerably facilitates the furtherance of its aims of investigating and making proposals for the international control of atomic energy in order to assist in the solution of this most pressing problem, and of helping to shape the policy of Britain in all matters relating to atomic energy. For implementing that second aim, and still more that of bringing before the public of Great Britain the true facts about atomic energy and its implications, the necessarily small body of experts requires, however, the support of the much larger body of informed public opinion. This can be provided by enlarging the membership of the Association by the institution of 'associate members', consisting of scientific workers and others who may not have special knowledge of atomic physics but wish to be associated with policy in this field. An appeal for associate members has now been issued over the signature of Prof. N. F. Mott, president of the Association.

The letter in which this appeal is made points out that men of science believe themselves to be fitted to take the lead in these matters because, on the technical aspects of atomic energy, they are the best-informed body. Moreover, those who have been involved in the development of the atomic bomb are deeply concerned about the problems to which it has given rise; before the War men of science took pride in the internationalism of their subject, and they are most anxious again to become a truly international body. To broaden the activities of the Association and especially to expand its publicity efforts, and to make the Association more effective, a large body of associate members is required. Such members will be in touch with the officers of the Association, and will receive free of charge all its publications, including the *News Letter* sent to full members. They can also write to the officers for advice about literature and information about atomic energy, and can express their own views and suggestions about the work of the Association. It is hoped that associate members will contribute generously, as substantial funds are required for effective work by the Association; the annual subscription of one guinea, which should be sent with applications for associate membership to Dr. C. O. Jones, Atomic Scientists' Association, Clarendon Laboratory, Parks Road, Oxford, is regarded as a minimum.

This appeal deserves a generous response, which should be stimulated by the recent broadcasts on atomic energy. Hitherto, the average citizen in Great Britain has had to depend on the views of individuals given sporadically, for guidance in decisions on this important and urgent topic. The extension of the activities of the Atomic Scientists' Association now contemplated should make for the formation of a sound body of public opinion such as is necessary for the guidance of governments in these times.

ANALYSIS AND PROPHECY IN SOCIAL STUDIES

Studies in the Development of Capitalism

By Maurice Dobb. Pp. ix+396. (London: George Routledge and Sons, Ltd., 1946.) 18*s*. net.

Revolution of Environment

By E. A. Gutkind. (International Library of Sociology and Social Reconstruction.) Pp. x+454+74 plates. (London: Kegan Paul and Co., Ltd., 1946.) 30*s*. net.

THOUGH widely different in subject-matter and approach, both these books are attempts to illuminate tendencies of the present by the analysis and synthesis of historical material, and both are concerned with the new opportunities for the development of civilization that now present themselves. In his introduction Dr. Gutkind directs attention to "the discrepancy between social conditions and the economic and technological possibilities" of the modern world, and calls for "an adjustment to new ways of life" by a "revolution of environment" that will produce a more balanced life within and between the nations. Mr. Dobb is concerned primarily with historical analysis, but he, too, has something to say of present trends, and his conclusions are of particular interest at a moment when the problems arising from a policy of 'full employment' and from the economic difficulties of Great Britain are so much in the air.

"Studies in the Development of Capitalism" is a work of synthesis rather than of original research, and Mr. Dobb as an economist is at pains in his introduction to placate both economists and historians who may feel that the book falls between two stools. He confesses, however, to "the obstinate belief that economic analysis only makes sense and can only bear fruit if it is joined to a study of historical development"; and, whatever the reader's view of his arguments and conclusions in detail, the result justifies the belief. In a series of studies Mr. Dobb sketches the development of capitalism from the decline of feudal society to the present day, showing the interplay of the various elements—the growth of the bourgeoisie and of the proletariat, the accumulation of industrial capital and the stimulus of invention and discovery—that together formed the capitalist system in its nineteenth-century heyday. His own definition of capitalism is essentially based on Marxist analysis, entailing as prerequisites of capitalist economy not merely the existence of the profit motive or of production for a distant market, but also the use of labour-power itself as a commodity, bought and sold by a limited class owning the means of production, and controlled by the wage contract. Less narrow definitions, as Mr. Dobb himself admits, would carry the story of capitalism beyond the historical limits he sets himself, but the need, as he sees it, is for "a definition to describe the distinctive economic institutions of the modern world of recent centuries", and as, despite appearances, he disclaims any intention of drawing frontiers between systems in history as "a sharp dividing line", he must be allowed his own definition. Of particular interest is the chapter on the "Growth of the Proletariat", in which Mr. Dobb stresses the point that it was factors other than the mere increase of population that produced the industrial proletariat of the nineteenth century: he neatly quotes J. S. Mill in support of the view that "it is influences affecting the proportion of the population in different social classes with which we are primarily concerned rather than influences affecting the size of the total population".

The general conclusion to which Mr. Dobb's argument leads is that "the economic situation of the hundred years between 1775 and 1875 was no more than a passing phase in the history of Capitalism, product of a set of circumstances which were destined, not only to pass, but in due course to generate their opposite", or, in the words of another writer, Prof. J. R. Hicks, whom he quotes, "nothing else but a vast secular boom". One therefore turns with interest to the last chapter, "The Period Between Two Wars", only to find little light on a confused period and a too ready identification of capitalism with Nazism. But it is, at any rate, clear that a process of development which has been going on for at least several centuries is now taking new forms, and Mr. Dobb sees emerging a form of State capitalism wherein "the focus of attention has radically shifted, and it is on the incentive to Labour—a satisfaction of its claims to a larger share of income, of leisure, of control and to a higher status, as the prerequisite of its co-operation in production—that any discussion of economic policy ultimately turns". Whether that is the final word we cannot yet say: the challenge now is rather to Labour than to Capital.

There is little that is new in Mr. Dobb's material or presentation, nor does he claim originality. But his study of some of the strands that go to make up our modern economic life is an interesting one, though regrettably less readable than it might be. As part of the story of our civilization it suffers perhaps from too narrow an approach. The view of capitalism here presented is likely to prove but a passing phase in a long record of oppression and misery from which man is only now beginning to emerge. Some slight corrections are called for in the book on points of detail: thus, in dealing with the formative seventeenth century Mr. Dobb persistently pre-dates the Commonwealth, and his acquaintance with Clarendon's career seems slight. But these are minor blemishes in a work of this scope.

Dr. Gutkind presents in his "Revolution of Environment" what cannot be called more than a selection of occasional papers. The underlying theme is the interaction of society and environment and the need to plan environment for the improvement of society. Illustrations are taken from China, Russia and the Jesuit settlement in Paraguay, and there is a series of striking plates which unfortunately bear neither numbers nor any definite relation to the text. Much interesting material is presented; but such conclusions as are drawn offer little guidance through current difficulties. Thus a delightful picture of Great Britain "after it has passed through its Revolution of Environment" is presented on p. 94, but it seems remote. Nevertheless, at a time when town and country planning are on the nation's agenda it is well that we should consider what we are aiming at, though perhaps Dr. Gutkind is over-zealous for "new men with new ideas striving towards new goals". New Presbyter may prove to be little more than Old Priest writ large. MAURICE BRUCE

SCIENCE AND CRIME

Forensic Chemistry

By Henry T. F. Rhodes. Second edition revised. Pp. vii + 164. (London: Chapman and Hall, Ltd., 1946.) 15*s*. net.

THE structure of the second edition of this work is essentially that of the earlier edition. In Part 1 of the book the author discusses the evidential value of skin-prints, occupational dust, and the grouping of blood and semen in the identification of the individual. Part 2, dealing with the application of chemical methods to the proof of *corpus delicti*, covers such miscellaneous matters as stains, firearms and explosives, questioned documents, counterfeit money and toxic agents.

Certain sections, notably those on dusts and stains, and on toxic agents, have been very largely re-written. Revision of the former sections has undoubtedly enhanced the usefulness of the book; but the inherent difficulty of treating so vast a subject as forensic chemistry in a volume of this size still reveals itself in a somewhat unbalanced product.

The author emphasizes in his preface that "the subject matter is strictly confined to formally chemical theory and technique". It is difficult to appreciate the insistence upon this rigid segregation of the science, and it appears to have been responsible for several serious omissions. In the short but lucid summary of blood grouping no reference is made, even in passing, to the absorption technique, while in the identification of blood stains, confirmation of the preliminary chemical tests by the precipitin reaction is entirely omitted.

The description of the utilization of micro-methods, and in particular of a micro-form of Stas-Otto procedure, in the examination of dust and debris is a commendable feature. Micro-methods are considered at length in several sections of the book, and some economy in space might well have been effected by the fairly safe assumption that those to whom forensic chemical investigations are entrusted are familiar with the general elementary technique of microanalysis. On the other hand, the spectrograph, that almost indispensable tool of the forensic chemist, is dismissed in three lines with the note that it "is not within the scope of this book", but that "in many cases it is very useful".

The chapter on questioned documents is by far the longest individual section in the book, and treats in an interesting and informative manner not only of the chemical examination of paper, inks and pencils, but also of such subsidiary materials as sealing-wax and adhesives. Sacrifice of the detailed discussion of the molecular structure of tannic acid and iron tannates would not detract from the quality of the chapter.

It is unfortunate that revision of the concluding chapter, on chemical toxicology, has not resulted in a more satisfactory treatment of the subject. Limitation of space inevitably precludes any detailed description of procedure (although arsenic is dealt with at inordinate length), but summaries of the basic processes for the separation of the main groups of poisons should certainly have been included.

The book, which is written throughout in the author's usual excellent literary style, is intended as a "practical guide for those engaged in forensic chemistry", and within its limited confines it provides a valuable introduction to many of the problems confronting the forensic analyst.

G. E. TURFITT

ANIMAL BIOLOGY

Principles of Animal Biology

By Prof. A. Franklin Shull, with the collaboration of Prof. George R. Larue and Alexander G. Ruthven. (McGraw-Hill Publications in the Zoological Sciences.) Sixth edition, second impression. Pp. xi + 425. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 20*s*.

THE necessity for a second impression of the sixth edition of this well-known text-book is sufficient evidence that it meets a widespread demand for a general elementary account of the principles of animal biology. It first appeared in 1920, and various changes have been introduced in successive editions; but those in the present edition are more than usually varied and affect the general plan. It may seem rather surprising to find one of the early chapters devoted to an account of some fundamental physics and chemistry, for apparently in the United States it is possible for a student to graduate in biology without any previous knowledge of those subjects. But in Britain there is a corresponding and probably more widespread ignorance among those graduating in chemistry or physics, who are frequently unacquainted with even the rudiments of any branch of biology.

The first part of the book deals with the functions of protoplasm, cells, cell division (in which the names of the phases of mitosis have been restored), leading on to the basic organisation of the Metazoa. Then follow chapters dealing with the functions of various systems, including the integration of activities by the nervous system and endocrine glands. This comprises a consideration of such diverse subjects as enzymes, photosynthesis, oxidation, muscle action, breathing movements, transfer of respiratory gases, blood composition, clotting, kidney function, vitamins, endocrines, the placenta, and reflex arcs. Reproduction, breeding behaviour and embryonic development are accompanied by a chapter on Mendelian heredity. An account of the general principles of taxonomy is a welcome feature, and there is a summary of the main groups of animals. The chapter on ecology has been enlarged by the addition of marine habitats, and is followed by a good description of the elements of the geographical distribution of animals, of palæontology and of the modification of species. There are a glossary of nearly forty pages and—for the American teacher—a most useful list of 16-mm. motion pictures and film strips that can be used to supplement some of the material in the book. Each film is listed under the first chapter to which it is applicable, and the running time of the film is given together with the addresses of the producers or distributors.

The way of the teacher is certainly made easy by the provision of a book of this nature, which can be thoroughly recommended for an elementary course in animal biology.

The book is well printed on good paper, and the line diagrams for the most part are clear and well chosen. It is all the more regrettable, therefore, that a certain number of very poor and badly reproduced figures should have been included, such as those illustrating the Chordata, and some of the photographs, that of T. H. Huxley being almost unrecognizable.

E. Hindle

STATISTICAL QUALITY CONTROL

Statistical Quality Control

By Prof. Eugene L. Grant. (McGraw-Hill Industrial Organisation and Management Series.) Pp. xii + 563. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 25*s*.

BEFORE the War, quality control methods of the statistical type were to be found in comparatively few industries. The War itself saw them introduced, frequently under Government auspices, into a wide range of industries which had previously never used them; and in consequence there was a sudden load on the available training centres, particularly in the United States, which had any acquaintance with this kind of work. Stanford University bore a full share in the training schemes which were drawn up, and Prof. Grant, who had been lecturing there on the applications of statistical methods to engineering for some seventeen years, found his field of engagements greatly enlarged. His experience as a teacher has now assumed concrete form in this book, which exhibits throughout a most admirable appreciation of the practical aspects of the subject.

The book falls into five parts. The first is introductory and gives the beginner a very clear idea of what statistical quality control can do. Part 2 deals with the control chart for variables based on sample means and ranges; and Part 3 deals similarly with charts for the control of fraction defective. Part 4 discusses the control of quality assurance and acceptance procedures based on single and double sampling techniques.

Thus far the author is on fairly familiar ground, though the abundance of his illustrations and the careful development of the basic ideas will make these sections well worth reading even for the expert. Prof. Grant then turns, in Part 5, to the practical problems of making quality control work, and has some most interesting comments on the cost and organisational factors involved in introducing statistical methods into a factory. The resistance to quality control from the managerial and technical side in some industries has, in fact, to be experienced to be believed. Nearly all the controller's activities "cross the lines of departmental authority", and it is far from easy to persuade the head of one department to increase his expenditure in order to make a larger reduction in costs in other departments. The successful director of a system of quality control has to be not merely a statistician and an engineer, but also a salesman, a psychologist and a diplomat.

The problem of teaching the engineer to think 'probabilistically' is in many ways an easy one. He need not worry about refinements in the theory of inference or torment himself with the question whether probability is a limiting frequency or an undefinable idea. His samples are as large as he likes to make them; probability for him is very much the same thing as relative frequency; and in the course of a very short time he accumulates so much data that he can convince himself that the ordinary laws of probability work in practice whatever their theoretical basis may be. For this reason the engineering world, from Shewhart onwards, has developed a sort of pragmatic frequency theory of probability. It may be difficult to justify logically, but it works. Prof. Grant accordingly introduces probability as a frequency concept, and it is enough for his purposes to take the direct theory as far as the derivation of the binomial and Poisson distributions. He does not require inverse probability at all, although, as he points out, some writers on quality control make an explicit use of Bayes' postulate.

There is a gratuitous footnote on page 112 which would be better omitted. "There seem to be," says the author, "two reasons why the standard error is so frequently misused in applications outside the field of quality control in manufacturing. One reason is that Shewhart's contributions to statistical theory, originally applied in manufacturing, are not so well known as they ought to be to statisticians in other fields. . . . The other reason is that statisticians in other fields are not subject to the immediate check on the accuracy of their predictions which is so common in manufacturing." One can share Prof. Grant's admiration of Dr. Shewhart, one of the pioneers in introducing quality control into industry; but I do not think Dr. Shewhart would claim to have made any contributions to statistical theory or to have taught statisticians anything they did not know about the use of standard errors. Prof. Grant invites the comment that the engineer should stick to his lathe.

But this is the only passage in the whole book to which I would take exception. The work is fluently written and well produced, and may confidently be commended to engineers and statisticians as an excellent account of the subject.

Maurice Kendall

ALEXANDER GRAHAM BELL AND THE INVENTION OF THE TELEPHONE*

By PROF. G. W. O. HOWE

ALEXANDER GRAHAM BELL was born in South Charlotte Street, Edinburgh, on March 3, 1847, the son of Alexander Melville Bell, who was a lecturer in elocution at the University, and whose father, Alexander Bell, was also a prominent teacher of elocution. This Alexander Bell had been a shoemaker in St. Andrews, but had removed to Edinburgh and taken up acting, giving public readings of Shakespeare's plays, and correcting stammering and other defects of speech. He then set up in London as a teacher of elocution.

In 1865, on the death of his father, Melville Bell removed from Edinburgh to London, leaving his Edinburgh pupils and business in the hands of his eldest son, Melville James. Melville Bell was appointed lecturer in elocution at University College. He was probably best known for his work on visible speech, that is, a method of teaching congenital deaf-mutes to speak, and it has been said that Miss Helen Keller is a living monument to his work.

Melville Bell had three sons, of whom Alexander Graham was the second. On leaving Edinburgh High School at the age of fifteen, Alexander Graham went for a year to Elgin as a pupil teacher; he then attended lectures in Greek and Latin at the University of Edinburgh for a year, and at seventeen returned to Elgin as a resident teacher of elocution and music. In 1867 his younger brother died of tuberculosis at the age of nineteen, and Alexander Graham took a post at Bath to be nearer his parents, going the following year to London to be his father's assistant and deputizing for him during his visits to America. He also attended classes in anatomy at University College. Then the elder brother in Edinburgh died suddenly, and as Alexander Graham's health was causing great anxiety, Melville Bell decided to leave London and settle in Brantford, Ontario. This was in 1870, and in the same year he was appointed professor of elocution at Queen's College, Kingston, Ontario. It will be seen that Alexander Graham Bell was born and brought up in an atmosphere of vocal physiology and phonetics. At their father's instigation, he and his elder brother, when schoolboys, had made a model of the mouth and vocal organs in gutta-percha and india-rubber, and operated the lips and tongue while blowing air through it. If it did not speak, it is at least reported to have made a very passable imitation of 'Ma-ma'.

While teaching in Elgin, Alexander tried to determine the pitch of the tones that constitute the various vowel sounds and the resonance pitches of the mouth cavities when shaped to pronounce a given vowel sound. He wrote a forty-page letter to his father about it, and his father consulted his friend Alexander J. Ellis, who later translated Helmholtz's "Sensations of Tone"; Ellis pointed out that Helmholtz had already done the same thing much more thoroughly and had also synthesized the vowel sounds by means of vibrating forks. Bell tried to repeat his experiments, but he confessed afterwards that his knowledge of the laws of electricity was too slight to enable him to understand the explanations given. Ellis lent him the book, but as it was in German, Bell could only study the diagrams and try to interpret them. One of his misunderstandings was very fortunate, for he gathered that Helmholtz had sent vowel sounds by telegraph, and it was two or three years before he found out his mistake. His mind started working on such things as the production of music by a number of electrically maintained forks operated by keys, and the possibility of transmitting the music over wires to a distance where there could be an electrically operated piano. He also thought of transmitting Morse signals by interruption of the musical note. He studied the various systems of telegraphy then in use and became familiar with Morse keys, sounders, etc.

After a year or two in Canada, his health was greatly improved, and he was invited by the Boston Board of Education to investigate the possibility of teaching the children in the school for deaf-mutes to speak by means of his father's system. He spent several months in a number of such schools in New England, and in October 1872 he settled in Boston as a teacher of visible speech, and in the following year was appointed professor of vocal physiology in the School of Oratory of the University of Boston. He was then twenty-six years of age and an elocutionist of the third generation.

Whatever else he might be doing, Bell devoted his spare time to experiments, and in 1874 he had a young instrument maker, Thomas A. Watson, make him a number of electromagnets each with a flat spring armature, one end of the spring being clamped on one pole and the other end free to vibrate over the other pole; those that were to be used as transmitters having make-and-break points like an electric bell. There were six or eight transmitters, all tuned to different frequencies by adjusting the springs and connected to the same number of distant receivers through a single telegraph wire. Each receiver was tuned to its appropriate transmitter and was expected to respond to no other, but to reproduce the dots and dashes by an intermittent tone having a certain pitch. Bell never succeeded in getting this so-called harmonic telegraph to work satisfactorily.

Although he devoted himself whole-heartedly to the development of this harmonic telegraph, he had the transmission of speech always at the back of his mind and discussed it occasionally with his assistant, Watson; but his future father-in-law, who was helping him financially, persuaded him to concentrate on the harmonic telegraph.

In June 1874 he gave an address to a convention of teachers of articulation to the deaf and dumb at Worcester, Mass., and demonstrated to them two instruments with which he did much experimenting. One was the manometric capsule of Koenig, which enabled a deaf person, by watching a sensitive flame in a rotating mirror, to note and try to imitate the wave-forms of the various vowel sounds. The other was Leon Scott's phonautograph, in which the membrane operated a bristle which traced the wave on a moving glass plate coated with lamp black. All this shows clearly that, to Bell, speech and wave-form were almost synonymous.

In February 1875 he went to Washington in connexion with patent applications for multiple telegraphy, and took the opportunity of calling upon Joseph Henry, who was secretary of the Smithsonian Institution, and was then seventy-six. He explained his idea of an articulate telephone; Henry told him that he thought it the germ of a great invention and advised him to work at it and not publish the idea. When Bell said that he felt that he had not the necessary electrical knowledge, Henry replied, "Get it." In a letter to his parents, Bell said, "I cannot tell you how those two words have encouraged me." Little did Henry and Bell dream as they sat talking that they would both, one day, be members of that small group of immortals—Ampère, Volta, Watt, Ohm, Faraday, Maxwell, Joule—whose names are for ever enshrined in the nomenclature of science.

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* Substance of a commemorative address before the Royal Society of Edinburgh on March 3.

It was on June 2, 1875, that something occurred which altered the whole course of events. Watson was in one room attending to the transmitting reeds, while Bell in an adjacent room put each receiving reed in turn against his ear and adjusted it until it was properly tuned to its respective transmitter. Suddenly Bell rushed in to see what was happening and, as Watson said, "the speaking telephone was born at that moment." What had happened was simply that the make-and-break points of one reed had welded together, and Watson had been plucking the reed to try to restart it, with the result that the sound that Bell heard was entirely changed. He saw at once that the receiver was being actuated, not by an intermittent current, but by an undulatory current in a closed circuit produced by the vibrations of the steel spring over the pole of the electromagnet due to the plucking. He told Watson to make a small drumhead of gold-beater's skin, with the centre joined to the free end of the steel spring by means of a small button of cork, and a mouthpiece over the drumhead. This was made at once and tested the following evening, but the results were not very successful. Although Watson could hear Bell's voice and almost catch the words, it required nine months further experimenting before Watson heard a complete and intelligible sentence. His patent application was filed on February 14, 1876, and the patent was granted on March 7. At that time a complete sentence of intelligible speech had not been transmitted, but a few days later, on March 10, Bell was trying his liquid transmitter in which the diaphragm carried a metallic wire dipping into a cup of acidulated water, and Watson heard the first complete sentence ever transmitted by the telephone. It was "Mr. Watson, come here; I want you." Contrary to the common fallacy that Bell only invented the electromagnetic telephone, claim 4 of his patent specification is for "the method of producing undulations in a continuous voltaic circuit by gradually increasing and diminishing the resistance of the circuit, or by gradually increasing and diminishing the power of the battery, as set forth".

During the summer of 1876 much progress was made, and by October tests were being made between Boston and Cambridge, a distance of two miles. Experiments were made with diaphragms of several feet diameter and with diaphragms as small as that of the human ear, with electromagnets and with permanent magnets of all shapes and sizes, and the present type of receiver gradually emerged. Bell used it both as receiver and transmitter; but it was necessary to speak very loudly in order to obtain satisfactory reception. The liquid transmitter was obviously not very suitable for practical use.

A very interesting coincidence occurred in connexion with Bell's patent application. He did not wish to make the American application until a similar application was lodged in London, and a friend who was going to London took a copy of the application and promised to send Bell a cable as soon as it was lodged. The cable never came and the application remained at the bottom of his friend's trunk. On February 14, 1876, his future father-in-law decided to wait no longer and lodged the application in Washington without consulting Bell. This was a fortunate decision, for an hour or two later on the same day Elisha Gray lodged a caveat which also described a liquid transmitter with an electromagnetic receiver. Another interesting point is that fifteen days after the patent was lodged, Bell altered the wording by substituting "*gradually* increasing and diminishing the resistance", for "*alternately* increasing and diminishing the resistance". This was doubtless intended to emphasize the undulatory nature of the current, which is stressed throughout the specification.

Within a few months Bell exhibited a liquid transmitter as well as the electromagnetic transmitter and receiver at the Philadelphia Centennial Exhibition. One of the judges at this exhibition was Sir William Thomson, afterwards Lord Kelvin, and in his address to the British Association in Glasgow on his return he said: "I heard 'To be, or not to be. There's the rub' through an electric telegraph wire, but scorning monosyllables, the electric articulation rose to higher flights and gave me messages taken at random from the New York newspapers. All this my own ears heard. This, the greatest by far of all the marvels of the electric telegraph, is due to a young countryman of my own, Mr. Graham Bell. Who can but admire the hardihood of invention which devised such very slight means to realize the mathematical conception that, if electricity is to convey all the delicacies of quality which distinguish articulate speech, the strength of the current must vary continuously and as nearly as may be in simple proportion to the velocity of a particle of the air constituting the sound." This was in June 1876, only four months after the lodging of his patent application. Sir William asked for the apparatus to be removed to the Judges' Hall for further tests, as he wanted Lady Thomson to hear it. It is interesting to know that Henry was also one of the judges and reported that Bell's invention was "the greatest marvel hitherto achieved by the telegraph".

The first outdoor telephone line was installed in Boston in 1877, and at that time Bell gave a number of lectures in New York and in most of the large cities of New England, at which demonstrations were given of telephone reproduction of distant singers and speakers. In August of the same year, Bell married and made a trip to England and Scotland. On October 31, 1877, he gave an address in London on "Researches in Electric Telephony", at a special meeting of the Society of Telegraph Engineers (now the Institution of Electrical Engineers). He concluded by saying that conversations had been carried on between New York and Boston, and that Mr. Preece, the engineer-in-chief to the Post Office, had informed him that conversations had been successfully carried on through a submarine cable between Dartmouth and Guernsey. Mr. and Mrs. Bell stayed eighteen months in Britain. Bell was kept busy, lecturing and clearing up the patent muddle caused by his friend's neglect to lodge the application in London before Sir William Thomson's return from America and his publication of all the details.

As an indication of the rapid appreciation of Bell's work and of the remarkable development of the telephone on the commercial side, the Western Union

Telegraph Company declined the offer of Bell's father-in-law to sell all the Bell patents for 100,000 dollars; this was early in 1876. Two years later it was said that the Company would gladly have given 25,000,000 dollars for them.

Bell's idea of using the same instrument as receiver and transmitter proved unsatisfactory because of its lack of sensitivity, and his company soon went over to the use of transmitters of the variable resistance type, acquiring the Blake transmitter in October 1878. In 1879 an agreement was made between the Western Union Company and the Bell Company whereby the latter had the use of the patents of Gray, Edison, Dolbear, and others, owned by the former company, who agreed that Bell was the inventor of the telephone and that his patents were valid and covered such things as transmitters using carbon contacts. But patent litigation went on for many years, the total number of actions involving the Bell patents reaching about six hundred. The great value of Bell's invention can be judged from the number and violence of the attacks made upon it, and its soundness from the complete failure of all the attacks.

On November 24, 1937, a tablet was unveiled on the house in which Alexander Graham Bell was born, and in the address following the function, I mentioned that it might be asked whether the statement that he was the inventor of the telephone was justified. Have not other men been given the credit for the invention? In accounts of early experiments one must not be misled by the use of the word telephone; it was used by Wheatstone and others before Bell was born, for the purely mechanical transmission of sound. The transmission of tones by means of an electric circuit was sometimes referred to as electric telephony; and finally, when speech transmission was attained, it was sometimes distinguished as articulate telephony or speech telephony.

The starting point of all the early experimenters seemed to be the phenomenon of magnetostriction discovered in 1837 by Page, and described by him in *Silliman's Journal* under the title of "The Production of Galvanic Music". If a coil is wound around an iron rod, then the rod emits a sound when the current is switched on and a louder sound when the circuit is suddenly opened. If the current is interrupted at an audible frequency, the rod will emit a musical tone, which can be amplified by mounting the rod on a sounding board. By varying the frequency of the interruptions the rod can be made to 'sing a tune'.

The late Silvanus Thompson wrote a book entitled "Philipp Reis, the Inventor of the Telephone". As I said in 1937, I read and re-read this book, and it removed any doubts which I may have had as to the justification for regarding Bell as the inventor of the telephone. Reis was a school teacher living near Frankfort-on-Main, who devoted years of patient research to the problem of telephony; he read papers and gave demonstrations at Frankfort and other places. After 1864, no further progress appears to have been made; the matter was allowed to drop, and Reis died in 1874. Thompson visited his home and interviewed his widow and others who had known Reis and taken part in his experiments; but there is no reliable evidence that Reis ever succeeded in transmitting a single sentence of intelligible speech. His transmitter was essentially a make-and-break apparatus, capable of transmitting tones and therefore tunes, and very simple vocal sounds. It consisted of a box with a mouthpiece into which one spoke; on the top of the box was a membrane carrying a thin strip of platinum; an arm carried a fine platinum point which was adjusted to touch the platinum strip on the membrane. His receiver was the singing iron rod of Page, mounted on a sounding board, which would respond to the make and break. In the light of our present knowledge—or even of the knowledge of the nature of speech which Bell possessed in 1875—it is obvious that such a make-and-break device could not possibly transmit intelligible speech.

A book entitled "Who Invented the Telephone?", by William Aitken, was published in 1939. It consists in the main of a very crude attack on Bell. It purports to give a reproduction of Bell's patent specification "somewhat abbreviated". On reading it, I wondered if Bell had really made such a muddled statement, but on consulting the actual specification I found it to be crystal clear; the apparent muddle was due entirely to the omission of an essential phrase.

Everyone who came into personal contact with Bell was impressed by his transparent honesty and his readiness to give due credit to other people, so much so that the Bell Company lawyers found it rather disconcerting. On returning from England in 1878, he was so tired of the patent squabbles and the prospect of having to fight unscrupulous rivals, that he decided to give it all up and return to teaching; but Watson, who was sent to Canada for the purpose, persuaded him to return with him to Boston and do his best to defend his patent rights.

For the next year or two he experimented with selenium and the problem of producing and reproducing sound by the agency of light—the photophone as he called it. In 1880 the French Government awarded him the Volta Prize of 50,000 francs which had been established by Napoleon. With this money he established in Washington the Volta Laboratory, and financed experimental work in which he was associated with his cousin, Chichester Bell, and Sumner Tainter. It was this Volta Laboratory Association that made the great advances in the gramophone, replacing Edison's hill-and-dale recording on tin foil by lateral cutting on a wax cylinder and later replacing the cylinder by a disk. When these patents were sold, Bell put his share of 200,000 dollars into the endowment of a Volta Bureau for the increase and diffusion of knowledge relating to the deaf.

In 1885 the Bell family visited Baddeck, in Nova Scotia, and were so pleased with it that Bell gradually acquired land there until he owned a headland which he called Beinn Bhreagh, on which he built a house and a laboratory. This was in 1892. For the remaining thirty years of his life his main interests were sheep breeding and aerial flight. In 1907 he formed an Aerial Experimental Establishment and gathered around him a group of experts. They experimented with man-carrying kites, aeroplanes and hydrofoils.

It was a memorable occasion when in 1915 the coast-to-coast telephone service was opened by Bell in New York and his old assistant Watson in San Francisco, a distance of 3,400 miles.

Bell died at his home in Nova Scotia on August 2, 1922, and was buried on the hilltop at Beinn Bhreagh. The coffin of pine boards was made in the laboratory workshop, and he was dressed in an old homespun working suit with the red button of the Legion of Honour in his buttonhole.

THE ECONOMIC POSITION OF GREAT BRITAIN

THE White Paper "Economic Survey for 1947" (H.M.S.O. Cmd. 7046. 1947. *6d.* net), which has followed the earlier "Statement on the Economic Considerations Affecting Relations between Employers and Workers" and the "Statement Relating to Defence" (Cmd. 7042. H.M.S.O., 1947. *2d.* net), gives a frank and sombre account of Great Britain's economic position. Less exhortative than the earlier one, its chief weakness is the absence of any real indication of the plan of action and the concerted measures by which the Government proposes to meet the danger. None the less, it is a most welcome instrument for educating the people of Great Britain in the true facts of the situation and their individual and collective implications, and every weapon of publicity should be used to bring those facts and implications home to every voter. As the Prime Minister rightly says in the foreword, it is the duty of any democratic Government to take the people frankly into its confidence, however difficult the position of the country may be; and again, "The Government alone cannot achieve success. Everything will depend upon the willing co-operation and determined efforts of all sections of the population. It is essential that all should understand that the maintenance and the raising of the standard of life of the people depends upon the extent to which every individual plays his or her part in contributing to the sum of goods and services available to the nation."

No exception can be taken to the presentation of the facts in the White Paper itself. They are displayed clearly and lucidly and cogently marshalled in support of the argument. There is first a section outlining the nature of economic planning and the considerations upon which democratic planning must be based. Thus early there is the frank warning that if more is required to satisfy any one of the five main national needs—defence, payment for imports, capital equipment and maintenance, personal consumption, and public services—which the twenty million workers in Great Britain, producing goods and services to the value of more than £8,500 millions a year have to satisfy, it can only be at the expense of the others, unless the total amount of work done is increased. If the total resources are reduced by unemployment or by a fall in the output per man-year, less of these requirements can be met.

The White Paper then proceeds to outline the conditions to which economic planning must conform in order to preserve the maximum possible freedom of choice to the individual citizen. Not only must there be regard to our special economic conditions; it is of the first importance that planning in Britain should be as flexible as possible. In avoiding the waste of unemployment, we should not destroy the essential flexibility of our economic life. The Government is seeking to develop a system which comprises an organisation able to gather sufficient knowledge and reliable information to assess the national resources and to formulate the national needs, a set of economic 'budgets' which relates these needs to the country's resources and enables the Government to determine the best use for the resources in the national interest, and methods the combined effect of which enables the Government to influence the use of resources in the desired direction, without interfering with democratic freedoms.

"Resources can be increased by increasing the labour force, or by a bigger output per man-year or by a combination of the two. A reduction in the labour force or a reduction in the output per man-year—by lower efficiency or by shorter hours or increased holidays unaccompanied by a compensating increase in hourly output—reduces the total resources and means that even less of the requirements can be met than before. Planning the allocation of resources between the various national plans is at present a task of deciding which out of a number of claimants must go short—in other words, which are the more important national priorities." While, however, the Government must lay down the economic tasks for the nation and say which things are the most important and what the objectives of policy should be, giving as much information as possible to guide the nation's economic activity and using its powers of economic control to influence the course of development in the right direction, the execution of the plan is a matter for co-operation between Government, industry and the people.

Reviewing next the period July 1945–December 1946, the Statement points out that the defence sector (armed forces and munitions) has been reduced from about 42 per cent of the nation's man-power to less than 10 per cent, and in this re-allocation unemployment in Great Britain never exceeded 2·5 per cent of the insured population, nor, in general, outside the Development Areas, 1·5 per cent. Exports have expanded to 110–115 per cent of the 1938 volume, and in 1946 industrial equipment and maintenance reached a normal pre-war year's work. Homes have been provided, by new building and repair, for nearly 300,000 families, and the way has been cleared for as rapid an expansion in house-building as the material supplies will permit. There has been little change on balance in food consumption; but a considerable expansion in supplies of manufactured goods to the home civilian markets to levels ranging from two-thirds to more than 100 per cent of pre-war years. Although far more plentiful supplies must be available than before the War to remove shortage in the shops, for a large section of the people the present food and clothing rations are more than they could normally afford even in good pre-war years.

In passing to the situation in 1947, the White Paper, like its predecessor, drives home the central fact that we have not enough resources to do all that we want to do, and barely enough to do all we must do. Whether we reckon in man-power, coal, electricity, steel or national production as a whole, to get all we want, production would have to be increased by at least twenty-five per cent. The essential priorities are picked out with brutal frankness: first importance must be attached to payment for imports and to basic industries and services, particularly coal and power. These requirements are then explained and related to the general plan, and the broad conclusion reached that the export target of 140 per cent of 1938 volume by the end of the year is of prime importance. Exports to the western hemisphere (and some European countries, with which we have deficits, namely, Sweden, Switzerland, Portugal) are of particular importance, for they earn dollars or the equivalent and pay for our essential imports from these countries. Close import control must be maintained, particularly of products which come predominantly from the western hemisphere. Home production must be increased along lines which contribute to these policies, agriculture and shipping being of major importance in this connexion. Special reliance, it is considered, should be placed upon a substantial growth of engineering, vehicle, chemical and miscellaneous exports. The labour force in manufacturing industry already employed on orders for export is about 50 per cent above the pre-war level, and is capable of further expansion provided that fuel and power supplies are adequate. These export targets cannot be achieved at all readily and sometimes not at all without reducing production available for the home market.

The basic fact of the position of Great Britain over the next few years is that we must devote at least 25 per cent of our manufacturing capacity to the production of exports; and we need to export more than this if we are to get the imports necessary to raise our standards of living. Equally important is the restoration of the full efficiency and productive power of our basic industries. Here it is urged that the 1947 industrial problem is fundamentally one of coal. We cannot afford to set a lower production target for the year than 200 million tons of coal, and this is barely enough for current use and for stock.

To achieve it the Government proposes to increase the labour force by making the industry attractive enough to draw the necessary number of recruits. Underground miners are to be exempt from call-up to the Forces for the next five years, and the National Union of Mineworkers has agreed to the employment of Poles in the mines. High priority is to be given to all measures which can contribute to increased coal production, such as the production and import of mechanized mining equipment and plant for open-cast coal production. The Government will take all possible measures to secure economy in the use of coal and give high priority to the conversion of engines and plant to oil burning. Drastic measures are to be taken to reduce non-industrial consumption of coal, gas and electricity, but the main emphasis in the coal budget is on increased output per man.

In regard to power, while the immediate crisis arises from lack of coal, even at full capacity the power stations of Great Britain cannot meet the demand, and although high priority is given to the production of new generating plant, some years will be required to make up the arrears. The steel shortage results from lack of imports and shortage of coal, but no serious gap is anticipated in 1947 between the supplies available and the essential needs of the major steel-consuming industries, provided that exports are cut to a minimum. Much re-equipment and maintenance work, however, is urgently demanded on the railways, and restoration of shipping is a major task. The Government's agricultural policy is to switch production from crops for direct human consumption to live-stock and live-stock products, especially pigs and poultry, but the world cereal shortage has delayed this policy. More agricultural workers are required; in the building industry, raw materials are the major obstacle to the building programme. There is just a hint that the output per man-year in this industry is far below the level which should be attained.

Reviewing these industries, the Statement indicates that for 1947 the Government is aiming at a distribution of work between capital equipment and maintenance of 48 per cent for new construction and 52 per cent for plant. The former includes 20 per cent for housing, 6 per cent for new industrial building—a figure which appears to be dangerously low, in view of its bearing on industrial efficiency—and 22 per cent for other building and maintenance, including war damage repairs. The latter is made up of 9 per cent for electricity, gas and Post Office; 4 per cent for roads, bridges, docks, harbours, canals, etc.; 15 per cent for railways, commercial road vehicles, shipping and civil aviation; and 24 per cent for plant for industry, mining and agriculture.

On defence, the White Paper provides for a reduction in the Armed Forces from the December 1946 level of 1,427,000 to 1,087,000 by the end of March 1948, and a fall in the number of workers supplying them. The housing programme is 240,000 new permanent houses and 60,000 temporary houses, and the amount of other capital equipment and maintenance work is to exceed that of a normal pre-war year by at least 15 per cent. Programmes for education, public health and national insurance are to go forward, and a proper degree of efficiency of the public services is to be maintained, with special reference to economy in man-power.

The key to success in reaching these objectives is man-power, and both a larger labour force and a higher output per man-hour are required. Moreover, the present geographical and industrial distribution of the labour force is unsatisfactory. Foreign labour is the only substantial means of increasing our prospective labour force of 18,300,000 men and women at December 1947, and while the Statement points out that the old arguments against foreign labour are no longer valid, it does not show a proper appreciation of the urgency of the situation to suggest that they are especially required for the under-manned industries: it is surely only there that such labour should be at present recruited if there is any meaning in the Government's plan. The Statement indicates that the Government contemplates an additional 100,000 workers from all sources, and sets forth the desirable distribution of the total 18,400,000 workers if its objectives are to be realized. "The size and distribution of the labour force are important, but what ultimately counts is the output which the nation produces. We shall not attain the objectives described without an increase in output per man a year. . . . In the longer view, increased output per man-year is the *only* way to expand production and the standard of living. . . . Increased efficiency in the supply of services is just as important as increased output per man-year in the production of goods. . . . Action which serves to reduce output per man-year in any industry is directly endangering the attainment of these objectives. The nation cannot afford shorter hours of work unless these can be shown to increase output per man-year. Greater leisure is a very desirable thing, but it is not at the moment a prime essential like imported food. It is not as important as coal or clothing or housing."

That is putting it bluntly, and much of it needs to be said at the present time. But it is disconcerting to read also that the Government only now proposes to invite the representative organisations of industry to co-operate with it in an attempt to establish the facts regarding output; or that it "attaches great importance to the introduction of systems of payment and other arrangements which provide the maximum incentive to increase output". For it is on Government action that the claim which the transport, distribution and other services make upon man-power largely depends.

Welcome emphasis is laid on research and development in the White Paper, which in referring to a start on longer-range planning for defence research and development with the constitution of the Defence Research Policy Committee, lays stress on the importance of encouraging scientific research and development at a time when economic considerations must severely limit expenditure on new equipment. Although there is evidence that, with the appointment of Sir Henry Tizard as chairman of the Advisory Council on Scientific Policy, knowledge of developments over the whole field of science will be pooled, to the benefit both of the civilian community and of national defence, there is not the same evidence of close co-operation elsewhere.

The references to the Defence Research Policy Committee are, however, encouraging. Through its close link with the Chiefs of Staff, the Committee will be continuously aware of the latest concepts of strategy and operational thought and will itself be able to influence those concepts by reason of its knowledge of future trends in the field of defence science. The Committee will also study programmes for research and development formulated by the Service and Supply Departments in connexion with the preparation of annual estimates, and it will also have brought before it all problems which arise on the higher organisation of defence research and development, and on the requirements of the Service and Supply Departments for scientific man-power, and also major projects for new establishments.

Such organisation providing for effective co-ordination of effort is the right instrument and condition for securing whole-hearted co-operation. It is essential that a like effort should be made in other fields. Co-operation, as Sir George Schuster has pointed out, is a two-way effort, demanding a lead from the Government as well as response from industry and from the nation. It requires organisation and much more than passive acquiescence in regulations or sporadic demands of the Government from individual interests. Whether or not industrial and trade associations become, as Sir George Schuster suggests, bodies to whom a general strategic task can be entrusted with confidence, to be worked out in close collaboration with the trade unions, no such instrument can be substituted for resolute leadership by the Government.

DEFECTIVE COLOUR VISION IN INDUSTRY

A COMMITTEE of the Colour Group of the Physical Society has performed a valuable task for the benefit of the community in preparing its recent "Report on Defective Colour Vision in Industry"*. It is written in a style which will be readily understandable by non-technical readers. Starting with a clear account of the nature and incidence of defective colour vision, it goes on to describe various colour vision tests, and mentions an almost alarming variety; an interesting chapter deals with colour vision in industry and the Services, from which it appears that there is a strong case for pre-vocational testing and routine examination of the colour vision of school children. A concluding chapter makes a series of recommendations, of which perhaps the most important is that "all children should be tested at school at the age of 13 or over, using one of the approved Confusion Chart Tests". Confusion chart tests are also suggested as suitable for pre-vocational tests for a great variety of industries and trades.

Defective colour vision is found, we are told, in about 8 per cent of the male population, but only in a much smaller percentage of women. Of the males, only about 2 per cent are 'dichromats', a class which can match all hues with an additive mixture of two suitable primary colours, and also would be liable to make the grossest errors in colour matching; but there are many in the remaining 6 per cent who, while not liable to confuse (say) reds and greens under good lighting conditions, nevertheless have inferior powers of colour discrimination and may make substantial mistakes if the light is poor. In this group are found the 'anomalous trichromats' who, while requiring *three* suitable primary colours to match all hues by these primaries combined in suitable proportions, nevertheless do not usually agree with such a match made by a normal person. It is important to realize, as is brought out by the report, that colour-defectiveness exists in many degrees of severity; there is no single condition which can be called 'colour blind'.

While the Services, public transport undertakings, and some industrial organisations prevent the entry of unsuitable persons by adequate tests, there is no consistent public policy in attempting to ensure that colour-defective persons do not become occupational misfits. The report instances the textile trades, drapery, electrical industries, paper-making, and many other cases in which a certain proportion (perhaps 20 per cent in some cases) of the employees must perform operations depending on sensitive colour discrimination. In many cases the matter is left to a kind of natural selection; people who find difficulty avoid such jobs, or they are found to be in difficulties and transferred to alternative posts. The Committee remarks in this connexion: "We have a clear impression that this loss of time and efficiency is by no means small, and that there would be real value, both from employers' and employees' points of view, in ensuring that colour-defective persons did not embark on lines of work where normal colour vision is necessary or highly desirable".

The result of a colour vision test is a matter of prime importance to the individual whose career may depend upon it. While stressing the importance of the elimination of colour-defectives from certain callings, the report proposes that the tests should occur before the individual has developed hopes which must be disappointed. We might add that any person failing should be convinced that justice has been done. While this last point is not neglected in the report, it does not seem to have been given enough weight.

The recommendation for the testing of school children is excellent, and there is no doubt that it should be implemented as soon as possible. There will be some boys who will have already been attracted to the Navy or merchant marine, and will, if colour-defective, have to turn their ambitions elsewhere. The defect is just as important in such a case as an error of refraction, and even if the test occupies five minutes of the time of a trained person, is that really an important objection? It is possible that the teachers, who already nobly carry a great burden of duties besides their normal teaching, might be able to include the first test as part of some instructive and amusing game in the ordinary school curriculum, and this without feeling that colour tests were the 'last straw'; there seems scope here for some invention by an educationist who is prepared to study the problem.

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* Report on Defective Colour Vision in Industry. By a Committee of the Colour Group. Pp. 52. (London: Physical Society, 1946.) 3*s*. 6*d*. net.

The report speaks in various places of the desirability of having well-printed cards for confusion chart tests, adequate lighting, proper refractive corrections, etc.: but these remarks do not appear adequately to reflect the immense importance which is rightly attached by the public to uniformity and justice in tests of this kind. In regard to one calling, the trade union concerned has taken a most active interest in such matters, and was reputed to go so far as to coach candidates in the tests. Even the school 'screening' tests should be uniform in character and adequately planned; a set of grimy cards, half-seen in a bad light, may make more trouble than they are worth. There are people who misunderstand the objects of such tests, and are capable of purchasing a set of cards for study in an attempt to defeat the examiner. If the screening test should be carefully conducted, this applies even more forcefully to the case of the testing of the doubtful cases classed in the report as Group II*a*. In spite of the convenience and undoubted effectiveness of the confusion chart method, the report leaves one with the impression that there is no guarantee that different sets of cards, even of the same supposed character, will not differ appreciably among themselves. This may not matter for a first screening test, but seems a serious drawback in the case of the decision (often difficult to make) as to whether a candidate is admissible to a particular vocation.

It may be that some means can be found of ensuring that confusion chart methods are properly controlled both in the production of the charts and their condition of use; but in this connexion my own experiences in an attempt to produce a standardized colour vision lantern may be of some interest.

In reviewing 'lantern' colour vision tests for entry to the Royal Navy, Commander Macleod found that there were considerable differences among the actual lanterns employed. A committee of the Medical Research Council, to which I had the honour of being co-opted, proposed to make the Board of Trade lantern test, known and well proved over a long period of time, the basis of a lantern test for the Royal Navy. The new lantern as re-designed, and made by Messrs. Kelvin Bottomley & Baird, Ltd., gives almost exactly the same effects as the Board of Trade lantern, except that perhaps the luminous equality of the lights is somewhat closer. Exact equality is too elusive a fox to chase, but by the helpful co-operation of the National Physical Laboratory and the makers, we were able to formulate a set of tolerances to which all lanterns could be produced, but not without considerable effort and care. A good many lanterns have had to be corrected before they passed the careful tests of the National Physical Laboratory. This lantern is the only one, so far as I know, which is regularly produced to conform to the Laboratory's specifications. This question of guaranteed equality and testing is not mentioned in the section of the report dealing with lantern tests, though it is the essential feature of the new lantern.

I have been at some pains to emphasize this question of uniformity because I feel that the vocational tests in particular are too important to be left to somewhat haphazard methods. The report comments, very justly, that if an electrician is tested by a matching test, using wires having clean coloured wrappings seen in a good light, he may not find the same difficulty that he does in practice when the light is poor and the wrappings dirty or faded. On the other hand, there are all degrees of dimness of light and fading, and it is possible that a person who failed in a supposedly 'realistic' test with one concern might pass in another. This may not matter much in the case of small industrial undertakings, which can please themselves about the tests they employ; but if, for example, entry to the Civil Service depends on a test, it ought to be reasonably uniform. On the bases of their possible standardization, and the satisfaction of the candidates with the tests, 'lanterns' have at present some claim to be considered for tests in cases other than those of mariners and transport workers. Every practical test is, in some degree, arbitrary.

Apart, however, from matters of secondary importance, the report should be of great public service in providing for the first time a clear general picture of the problem, and the lines along which its solution should be attempted. The rewards of success will lie in a small but definite improvement in the efficiency of industry, and (much more important) the avoidance of the disappointment and difficulty which may invade the lives of those who are unfortunate enough to suffer from defective colour vision. It is much to be hoped that the report will be carefully read by all educational authorities and persons concerned with recruitment for industry and the professions. L. C. MARTIN

OBITUARIES

Dame Margaret Tuke, D.B.E.

THE largely attended memorial service in St. Paul's Cathedral on March 11 was a tribute to the memory of a woman who gave the best years of her life to the cause of women's education and who, by her inspiration and leadership, brought Bedford College to the forefront of British university colleges for women.

Dame Margaret Tuke, who died on February 21 at the age of eighty-four, was the daughter of James Hack Tuke, of Hitchin, Herts. She was educated at St. John's, Withdean, Brighton, from which school she proceeded to Newnham College, Cambridge, where she read for the Medieval and Modern Languages Tripos. She was appointed to a lectureship in modern languages at Newnham in 1890 and continued in Cambridge until 1905, in which year she accepted the tutorship to women students and a lectureship in French at University College, Bristol. After two years at Bristol, she was appointed principal of Bedford College for Women, then occupying inadequate buildings in Baker Street, London. During Miss Tuke's tenure of the principalship, the College grew in size and importance, and its academic standing became firmly established. It was moved to its present site in Regent's Park and, largely owing to her initiative and energy, extended its range of studies considerably, especially in the natural sciences. Laboratories for botany, chemistry, geology, physics, physiology and zoology were opened, designed to provide adequate facilities for advanced teaching and research work. Additions were also made to the number of subjects in the Faculty of

Arts for which teaching was provided, and Bedford College became one of the most important as well as the largest of the colleges for women in the universities of Great Britain.

Dame Margaret's services to the University of London were notable. It was only four years after her appointment to Bedford College that she was elected to represent the Faculty of Arts on the University Senate, and she was repeatedly re-elected in this capacity until her retirement in 1929. It was very unusual for the head of a college to be elected by the professors, readers and teachers of a faculty as one of their Senate representatives; but the Faculty of Arts had been quick to recognize the administrative ability of the new principal of Bedford, and to see that she would be a tactful advocate of their views. She was an active member of the Academic Council from 1911 until 1929, and also served on a score or more of Senate committees dealing with a wide range of matters, scholastic and social. Of some of these she served as chairman, notably of the University Scholarships Committee, to the work of which she devoted much time when the annual awards were under consideration. Her views on university matters commanded attention and respect. She was responsive to new ideas and encouraging to the younger generation and to colleagues who desired to see improvements made in courses of study or examinations. For her services to education she was created D.B.E. in 1932. The honorary degree of D.Litt. was conferred upon her by the University of Reading in 1937. She was a fellow of Newnham College, Cambridge, from 1905 until 1936.

Dame Margaret was unassuming in manner and blessed with a quiet charm and a ready smile—sometimes said to be a disarming asset. There are gifts of courtesy and kindness which are always recognized and are particularly valuable in one holding an administrative appointment, for they serve to soften the unavoidable asperities which such an office may involve. Dame Margaret Tuke possessed these gifts in a very special degree, and leaves behind her a memory which is sweet and fragrant—a memory which those who were privileged to know her will always treasure. FRANK HORTON

Prof. P. M. Roxby

PROF. PERCY MAUDE ROXBY, as his second name and surname imply, belonged by descent to families long known for service to our public life, especially in the Church. He was the youngest son of the Rev. H. M. Roxby, vicar of Buckden, Hunts, and it is highly characteristic that he had taken a house at Buckden with a view to retirement there, so deep were his attachments to the rural tradition of England, in spite of all the devotion he had lavished upon the University of Liverpool and its students over a period of forty years.

Born on November 21, 1880, Roxby was educated at Bromsgrove School and Christ Church, Oxford, to which he went with an open scholarship in history. He followed this up by gaining the Gladstone Memorial Prize in 1902 and a first-class in modern history in 1903. After graduation, he studied under Prof. A. J. Herbertson, then recently settled in Oxford as head of the Geography Department. Before he had completed his projected scheme, the University of Liverpool inquired for someone to teach geography, and Herbertson sent Roxby to begin what was to be a great life-work as a teacher. After various preliminary stages he was given a full lectureship with the responsibility for geography in the University of Liverpool in 1908. He was awarded the Albert Kahn Travelling Fellowship in 1912 and visited the United States, India and China, beginning in connexion with the last-named what became a life-long attachment and devotion. In 1917 a new chair of geography was given to Liverpool in recognition of Roxby's work, and he held the professorship until 1944.

Roxby's welcome to foreign students in his department brought him notable recruits, including some like Prof. Chang from China and Profs. Amer, Awad, Huzayyin and others from Egypt. He was given leave to act as a member of the China Education Commission in 1921 and, with this added experience of the East, he wrote valuable articles to help teachers and students to understand and interpret China. In 1930 he was invited to act for a year as visiting professor in the Egyptian University at Cairo, where some of his students were implanting his tradition. In the same year he became president of the Geographical Section of the British Association for the Advancement of Science, and his address was a notable plea for the humanist approach to geography.

Under such a vital teacher, the friend of all his students, the Geography Department at Liverpool grew and became one of the acknowledged sources of strength of the University. In addition to lectures, discussions, and help with essays and theses, Roxby gave his time without stint to his students and their problems, personal as well as scientific. He also spent perhaps too much of his time and strength on geographical, educational and international study groups up and down the country without thought of fee or reward. His position as an acknowledged leader of efforts for international understanding became clear as the years passed, and he devoted much thought to committees promoting cultural relations with China and Chinese universities. This ceaseless activity perhaps lessened his output of printed work, but he contributed articles on China to the "Encyclopædia Britannica" and to various reviews, and this culminated in his editing of the Naval Intelligence Handbook on China printed for official use during the 1939–45 war period. It is greatly to be hoped that this monumental work, to which he contributed so much, may soon be made available for general use.

During the War, Roxby's school of geography was to a large extent evacuated from Liverpool to Harlech, and Roxby became for a while responsible for the part of the University of Liverpool installed in that beautiful mountain region, which made a strong appeal to him and led him to encourage students before and after graduation to concern themselves with studies of Wales. If, however, China, Egypt, Lancashire, East Anglia and Wales held his special interest, as a stream of publications by his students indicates, his sympathies were universal, and all superiority complexes were alien to his open mind, which yet maintained a strong loyalty to his own origins.

In 1944 the British Council invited Roxby to become its chief representative in China, and this led him to anticipate his retirement from the University of Liverpool, where he had for so long been an outstanding and beloved member of the professorial staff. He had married in 1941 Miss M. P. Howden, lecturer in history in the University, and with Mrs.

of water in all three phases, the vertical velocity and the turbulent transfer of heat. Some of these factors have never been established inside clouds. Others can only be measured with great difficulty. Much further research is required.

The experiments are part of the programme of the Council for Scientific and Industrial Research, Commonwealth of Australia, in which the Divisions of Physics and Radiophysics are collaborating. We wish to acknowledge the work of Messrs. Harper and Kemp of the Division of Physics in making laboratory experiments which provided data for the full-scale tests. We wish also to make acknowledgment to the crews of No. 82 Wing, Royal Australian Air Force, who were responsible for the flying, to Mr. Heffernan who took part in most of the flights, and to Dr. E. G. Bowen, Chief of the Division of Radiophysics, for his enthusiastic support.

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[1] Union Géodesique et Géophysique International (Lisbon, 1933).

[2] Science Newsletter, Washington (November 23, 1946).

[3] Volmer, "Kinetik der Phasenbildung", reprinted by Edwards Brothers, Ann Arbor, Michigan.

TOXIC ORGANO-LEAD COMPOUNDS

By Dr. H. McCOMBIE

AND

Dr. B. C. SAUNDERS

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THIS work began in Cambridge in 1939 with the original purpose of preparing compounds of the type PbR_4 which might be toxic by inhalation. It should be noted that, at that time, supplies of arsenic in Great Britain were very much reduced, whereas lead was readily available. Compounds which we contemplated preparing were $(C_2H_5)_2Pb(CH_2CH = CH_2)_2$, $(C_2H_5)_2Pb(CH_2CH_2Cl)_2$ and $Pb(CH_2CH_2Cl)_4$, etc. As an intermediate, it was necessary to prepare triethyl lead chloride $(C_2H_5)_3PbCl$ in quantity, and one of us (B. C. S.), while working with this compound, developed the symptoms of a severe attack of influenza, which, however, wore off at night and returned during the day. The compound was therefore tested for sternutatory properties, and found to produce, at a concentration of one part in a million, an atmosphere in which respiration was difficult.

This discovery then gave a great impetus to the preparation of triethyl lead salts. The original intention of preparing substituted plumbanes was postponed, and the preparation and detailed examination of trialkyl lead compounds were then undertaken. Several hundred compounds were prepared, many of which were new. They were tested as potential sternutators at Cambridge, and reports on these compounds were submitted by us to the Ministry of Supply during the years 1940–41. These reports were also made available to American workers.

It was found that passing reference had been made to the irritant properties of certain trialkyl lead salts by earlier investigators, for example, Krause and Pohland[1]. Gilman and Robinson[2] had noted that sneezing was caused by dust containing triethyl lead salts. No systematic attempt, however, had ever been made to correlate potency with the nature of the constituent groupings, and no compound of high sternutatory power had been recorded. In the present work, emphasis was placed on the production of substances which had the following characteristics: (i) ease of preparation, (ii) reasonable stability, (iii) strong sternutatory action.

A full account of the methods of preparation will be given in the appropriate journals later. Many of the compounds were easily obtained in a highly crystalline pure condition, and have not deteriorated on being stored for several years.

Physiological Examination

Examination of the physiological action of these compounds on ourselves and members of the team was carried out in a glass-walled chamber of 10 c.m. capacity. The substance under test was dissolved in a suitable solvent, and dispersed in the chamber by means of a spray operated by compressed air. Suitably placed fans ensured, so far as possible, an even distribution of the material in the atmosphere inside the chamber. The human observers, four in number, entered the chamber by an air-lock as soon as spraying was complete. The times which then elapsed before irritation occurred in the nose, throat, chest, and gums were noted. Unless the substance proved to be intolerable, the observers stayed in the chamber for 10 minutes. From the data thus compiled, a toxicity rating for a given concentration could be allotted to each compound.

The first concentration to be tried was 1 molecule of the substance in 10,000,000 molecules of air, that is, about 15 mgm. of organo-lead compound were actually dispersed in the chamber. The required amount was dissolved in about 15 ml. of solvent (usually alcohol). For certain of the more potent substances, tests were carried out at concentrations of 1 : 25,000,000.

Triethyl lead chloride, $(C_2H_5)_3PbCl$, was taken as an arbitrary standard, and all other compounds were put into various categories in comparison with this standard. Thus, triethyl lead monochloroacetate, triethyl lead monobromoacetate, triethyl lead cyanate were found to produce effects similar to those produced by triethyl lead chloride at the same molecular concentration[3,4]. The following were examples of triethyl lead salts which were superior as sternutators to triethyl lead chloride:

triethyl lead acetate;
" " cyanide;
" " crotonate;
" " *iso*-valerate;
triethyl lead *p*-toluene sulphonate;
" " thiocyanate;
" " β-chloropropionate.

Certain triethyl lead compounds, for example, triethyl lead selenocyanide, were slightly inferior in their sternutatory effect to the standard triethyl lead chloride.

All trimethyl lead salts (for example, $(CH_3)_3PbCl$, $(CH_3)_3PbO.CO.CH_2Cl$, $(CH_3)_3Pb.O.CO.CH_2CH_2CH(CH_3)_2$) were markedly inferior, irrespective of the acid radical, to all salts of the triethyl lead series. In fact, all trimethyl lead salts produced atmospheres which caused only very mild discomfort at a concentration of 1 part in a million.

Tri-*n*-propyl Lead Salts

Regarding homologues above the triethyl series, we definitely established[3,4,5,6] that derivatives of tri-*n*-propyl lead were without exception markedly more effective than the corresponding compounds of the triethyl lead series. A falling off of potency was, however, noted in the tri-*n*-butyl series, and these compounds were always inferior to the corresponding compounds in the tri-*n*-propyl series, but usually superior to compounds of the triethyl lead series. Tri-*iso*butyl lead salts were also usually inferior to tri-*n*-propyl lead salts.

Of the numerous tri-*n*-propyl lead salts prepared and examined the following may be mentioned:

tri-*n*-propyl lead acetate;
,, ,, bromoacetate
,, ,, iodoacetate;
,, ,, trichloroacetate
,, ,, β-chloropropionate;
tri-*n*-propyl lead *n*-butyrate;
,, ,, *iso*-valerate
,, ,, acrylate;
,, ,, *o*-toluene sulphonate;
,, ,, *p*-toluene sulphonate.

Of the above, tri-*n*-propyl lead acrylate[7,8] was the most potent.

Examples of tri-*n*-butyl lead salts and tri-*iso*butyl lead salts which were superior to triethyl lead chloride in respect of sternutatory properties were:

tri-*n*-butyl lead chloride
,, ,, acetate;
,, ,, bromoacetate;
,, ,, iodoacetate;
,, ,, trichloroacetate;
,, ,, propionate
tri-*n*-butyl lead β-chloropropionate;
,, ,, crotonate;
tri-*iso*butyl lead chloride;
,, ,, acetate;
,, ,, butyrate;
,, ,, *p*-toluene sulphonate.

Dialkyl Lead Salts

We found that, without exception, diethyl lead salts (for example, diethyl lead dichloride $(C_2H_5)_2PbCl_2$) were almost devoid of sternutatory properties. This absence of sternutatory power was independent of the acid radical, for diethyl lead dichloride, dithiocyanate, dibenzoate, di-3 : 5-dinitrobenzoate[6] were all equally ineffective. Even in the *n*-propyl series, the di-*n*-propyl lead salts were found to possess extremely feeble sternutatory properties in spite of the fact that the *n*-propyl radical enhanced potency so markedly in the tri-*n*-propyl lead series.

A New Method for Preparing Diethyl Lead Salts

Triethyl lead salts are readily prepared by neutralizing a solution of triethyl lead hydroxide with the appropriate acid[3]:

$$(C_2H_5)_3PbOH + CH_3CH{:}CHCOOH = (C_2H_5)_3PbO.CO.CH{:}CH.CH_3 + H_2O.$$

When a plumbane is treated with a monobasic acid and silica gel, it has been found that, in some instances, the trialkyl lead salt is produced, whereas in other cases the dialkyl lead salt is formed; for example:

$$(C_2H_5)_4Pb + CH_3COOH = (C_2H_5)_3Pb.O.CO.CH_3 + C_2H_6$$
$$(C_2H_5)_4Pb + 2C_6H_5COOH = (C_2H_5)_2Pb(O.CO.C_6H_5)_2 + 2C_2H_6.$$

It is not always quite clear what governs this difference, although in some cases the strength of the acid seems to be one of the controlling factors[7]. Very frequently the analyses of the two types of salts are close, and an independent method of preparing the diethyl lead salts was obviously essential in order to establish definitely their identity.

In 1940 we showed[3] that moist sulphur dioxide reacted with lead tetraethyl producing *diethyl lead sulphite*, $(C_2H_5)_2PbSO_3$. Later, we discovered that this compound reacted smoothly with a number of acids producing diethyl lead salts:

$$(C_2H_5)_2PbSO_3 + 2CH_2ClCOOH = (C_2H_5)_2Pb(O.CO.CH_2Cl)_2 + SO_2 + H_2O.$$

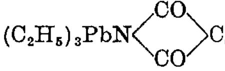
The compound prepared in this way was different from the compound obtained by the action of chloroacetic acid on lead tetraethyl, and this second compound was identical with the product obtained by the neutralization of triethyl lead hydroxide by chloroacetic acid.

Before leaving dialkyl lead salts, mention should be made of the disproportionation of diethyl lead di-monochloroacetate[7], which we found to proceed in hot aqueous solution as follows:

$$2(C_2H_5)_2Pb(OCOCH_2Cl)_2 = (C_2H_5)_3PbOCOCH_2Cl + Pb(O.CO.CH_2Cl)_2 + ClCH_2COOC_2H_5.$$

Di-*n*-propyl lead diacetate behaved similarly. In view of this facile disproportionation, it is rather surprising that dialkyl lead salts are so ineffective as sternutators.

New Types of Trialkyl Lead Compounds

In addition to the simple trialkyl lead salts mentioned above, we also directed our attention to the synthesis and examination of new types of organo lead compounds[3,5], such as triethyl lead phthalimide  $(C_2H_5)_3PbN\langle{}^{CO}_{CO}\rangle C_6H_4$, triethyl lead ethyl sulphide, $(C_2H_5)_3PbSC_2H_5$, and triethyl lead phenyl sulphide $(C_2H_5)_3PbSC_6H_5$. The first of these compounds is a solid. The sulphides are liquids soluble in non-polar solvents and prepared from triethyl lead hydroxide and the corresponding mercaptan. Triethyl lead ethyl sulphide can be distilled under reduced pressure and possesses an odour resembling that of horseradish. All three possessed sternutatory properties similar to that shown by triethyl lead chloride. Tri-*n*-propyl lead phthalimide[5] was also prepared and, in accordance with expectation, was found to be more potent than triethyl lead phthalimide.

Sulphonamides Containing Lead

In October 1940 we prepared[5,6] a new and interesting type of compound, namely, triethyl lead *p*-toluene sulphonamide, $CH_3C_6H_4SO_2NHPb(C_2H_5)_3$. This highly crystalline compound, recrystallizable from benzene, was obtained in 73 per cent yield by heating the sodium derivative of *p*-toluene sulphonamide with triethyl lead chloride in alcoholic solution:

$$CH_3C_6H_4SO_2NHNa + ClPb(C_2H_5)_3 = CH_3C_6H_4SO_2NHPb(C_2H_5)_3 + NaCl.$$

It was found to be the best lead sternutator examined up to that time, and was intolerable at a concentration of 1 in 10,000,000.

This led to an extensive investigation of this and related compounds, and we later showed[7] that a very simple and satisfactory method of preparation consisted of mixing, in the cold, alcoholic solutions of *p*-toluene sulphonamide and of triethyl lead hydroxide, and then adding water to precipitate the substituted sulphonamide. An almost pure product was obtained even before recrystallization, and the yield was 80 per cent.

$$CH_3C_6H_4SO_2NH_2 + (C_2H_5)_3PbOH = CH_3C_6H_4SO_2NHPb(C_2H_5)_3 + H_2O.$$

In accordance with expectation, tri-*n*-propyl lead *p*-toluene sulphonamide was more potent than the triethyl compound. Similarly, tri-*n*-propyl lead benzene sulphonamide (which was obtained in 93 per cent yield from tri-*n*-propyl lead hydroxide) was a powerful sternutator, and at a concentration of 1 part in 10^7 all observers were forced to leave the chamber at the end of 40 sec.[6]. In addition to its sternutatory effect, this compound produced a pronounced irritation on the fingers and faces of some of the workers who were concerned with its prepara-

Roxby he went out to China in 1945, making plans to help Chinese colleagues in educational and other fields to rehabilitate their cultural life after the dislocation due to so many years of war. Roxby was no westernizer; he loved Chinese thought and Chinese art, and at the same time felt deeply the problem of Chinese rural poverty. One may say that he carried on at least two life-works, one for geographical thought in Great Britain, and especially at the University of Liverpool, and one for and in China. His work for Egypt was scarcely less. His students have spread far and wide, and much of his thought is included in their published work, which habitually refers to him as the source from which they have derived their inspiration. His colleagues in other universities found his selfless co-operation a great support and encouragement, and his help to the Geographical Association through many years is gratefully acknowledged. H. J. FLEURE

WE regret to announce the following deaths:

Prof. V. M. Goldschmidt, For.Mem.R.S., formerly professor of geology and mineralogy in the University of Oslo, on March 20.

Sir Halford Mackinder, P.C., sometime director of the London School of Economics and formerly professor of geography in the University of London, on March 6, aged eighty-six.

Prof. B. A. McSwiney, F.R.S., professor of physiology, Sherrington School of Physiology, St. Thomas's Hospital, London, on March 8, aged fifty-two.

Dr. Walter Ramsden, senior fellow of Pembroke College, Oxford, and emeritus professor of biochemistry in the University of Liverpool, on March 26, aged seventy-eight.

Dr. Alexander Scott, F.R.S., formerly director of scientific research at the British Museum, on March 10, aged ninety-three.

NEWS and VIEWS

Astrophysics at Cambridge: Prof. F. J. M. Stratton, O.B.E., F.R.S.

PROF. F. J. M. STRATTON retires from the chair of astrophysics at Cambridge on September 30. Thus will end an official connexion with the Solar Physics Observatory which dates back to 1909. In that year he was appointed assistant in astrophysics at the Newall Telescope, Cambridge Observatory, while in 1913, when the astronomical work at South Kensington was fused with that of the Newall Telescope under the name of the Solar Physics Observatory, he became assistant director to Prof. H. F. Newall. After the First World War, in which he served with distinction in the Royal Engineers, Stratton was forced by the pressure of his College duties to resign his official post at the Observatory. His research, however, was still carried on from there, and on the retirement of Newall in 1928 Stratton was appointed to the chair of astrophysics and to the directorship of the Observatory. Through his efforts, aided by those of happily chosen successive assistant directors, the Solar Physics Observatory has become to-day, it will be generally agreed, the leading centre for astrophysical research in Great Britain and the training ground for astronomers from many lands.

Prof. Stratton's own researches have covered a wide field, ranging from problems in gravitational and positional astronomy to investigations in astrophysics. He is best known, however, for his work on novæ—initiated by his brilliant discovery of A-type and B-type absorption lines simultaneously appearing in the spectrum of Nova Geminorum II, each type with its own velocity displacement, and culminating in his work on Nova Herculis 1934 and the magnificent atlas of its spectra. He has been an assiduous observer of solar eclipses, and the ultra-violet spectra secured by C. R. Davidson and him of the solar chromosphere at Sumatra in 1926, one of the few occasions on which he has experienced clear skies, have clarified many problems in solar physics. Those who know Prof. Stratton best expect that official retirement will be the signal for a fresh burst of activity, and they look forward to further research and to his beneficent presence at international meetings of astronomers for many years to come.

Dr. R. O. Redman, F.R.S.

DR. R. O. REDMAN, chief assistant at the Radcliffe Observatory, Pretoria, has been appointed professor of astrophysics and director of the Observatories of the University of Cambridge on the retirement of Prof. F. J. M. Stratton. A Sheepshanks Exhibitioner and Isaac Newton Student at Cambridge, he spent part of his time as a student at the Dominion Astrophysical Observatory, Victoria, under Prof. J. S. Plaskett. His work there on the galactic rotation of late-type stars led to his return to Cambridge as assistant director of the Solar Physics Observatory and fellow of St. John's College. His experience with the 72-inch Victoria reflector made him an obvious choice as chief assistant to Dr. Knox Shaw when the Radcliffe Observatory moved from Oxford to Pretoria to complete for the southern sky the work of the Victoria telescope in the northern hemisphere. A series of unhappy delays has so far prevented the Radcliffe Observer and his staff from getting the 74-inch mirror with which the programme was to have been carried out, and Dr. Redman returns with some of his plans unfulfilled. But he has from his days at Victoria, Cambridge, and Pretoria a good volume of first-class work to his credit, mainly in the spheres of photometry and spectrophotometry. With close attention to the instrumental conditions essential to success, he has made very careful studies of the contours of Fraunhofer lines both at the centre of the sun's disk and on the limb, of chromospheric lines as seen at a total eclipse and of the absorption lines at different stages of eclipse of one component of a binary star. He has been a member of four eclipse expeditions, in 1927, 1932, 1936 and 1940. In 1940 he was favoured with fine weather, and secured some valuable spectrographic observations: the high temperature, 30,000°, which he found for the chromosphere and the strength of the weak Fraunhofer lines at the extreme limb of the sun are results which are not yet fully understood. His direct photometry includes work on the Andromeda and other nebulæ and on the use of the Fabry method in stellar photometry. He is at present co-operating with Dr. Stoy of the Cape Observatory on standard stellar magnitudes for the southern sky.

Scientific Civil Service: Promotion of Individual Research Workers

It will be recalled that in the Government White Paper on the Scientific Civil Service (Cmd. 6679) provision was made for the creation of special posts above the level of 'principal scientific officer' to provide for the promotion of individual research men of exceptional quality who would not necessarily have administrative responsibility. Such posts were to be additional to normal departmental complements. Departments were to be invited to nominate members of their staff for appointment to such posts, and these nominations were to be considered first by the Interdepartmental Scientific Panel, which would make recommendations on them to the Treasury. The first appointments under this scheme have now been authorized for the undermentioned members of the Scientific Civil Service, who have been promoted to the grade of 'senior principal scientific officer' (basic salary scale £1,200–1,400) with effect from January 1, 1947. This is the first fruit of what is intended to be an annual review.

J. W. Barnes (Ministry of Supply), a research engineer engaged in the more fundamental aspects of gyroscopic techniques and the design of aircraft equipment. Dr. J. Bronowski (Ministry of Works), author of numerous papers in algebraic geometry; engaged in mathematical and statistical investigations connected with structure of industry, with special application to the building industries. H. L. Cox (Department of Scientific and Industrial Research), an authority on structural problems in aircraft; has made notable contributions to the simplification of engineering research problems by mathematical treatment. Dr. G. E. R. Deacon (Admiralty), a physical chemist who has specialized in oceanography; has taken part in several "Discovery" expeditions to the Antarctic; elected a fellow of the Royal Society in 1944. S. B. Gates (Ministry of Supply), engaged on aerodynamic research with special reference to the stability and control characteristics of aircraft. Dr. J. A. Lovern (Department of Scientific and Industrial Research), known for his fundamental research on the fats of fish and other aquatic animals; has had wide experience of technological problems relating to the handling and processing of fish. J. Morris (Ministry of Supply), an applied mathematician specializing on structural and vibration engineering problems in aircraft. H. B. Squire (Ministry of Supply), an applied mathematician in the field of theoretical aerodynamics, with special reference to problems of supersonic flight, fluid motion and helicopter stability. Dr. W. S. Stiles (Department of Scientific and Industrial Research), an authority on problems of vision with special reference to the sensitivity of different retinal areas to light of various colours, and the efficiency of different parts of the pupil. B. Sykes (Ministry of Supply), a research engineer engaged in the more fundamental aspects of design of aircraft instruments; has made noted contributions to the predictor gun sights of aircraft. Dr. A. M. Turing (Department of Scientific and Industrial Research), author of an important paper "On Computable Numbers" (*Proc. London Math. Soc.*, 1937) which contained the basic idea of the automatic computing machine now being developed at the National Physical Laboratory. Dr. A. M. Uttley (Ministry of Supply), who was earlier engaged in research on visual perception, and more recently on a variety of electronic researches including R.A.F. training equipment, servo mechanisms and astro navigation. Dr. W. H. J. Vernon (Department of Scientific and Industrial Research), a leading authority on the corrosion of metals. Dr. D. Williams (Ministry of Supply), a research engineer and applied mathematician in the field of structures of aircraft.

Further Education

It is peculiarly appropriate that the Turnstile Press, Ltd. (10 Great Turnstile, London, W.C.1), should announce for publication in April the first number of a new educational monthly entitled *Further Education.* The Ministry of Education is now taking active measures to ensure that local education authorities, acting in the closest association with industry, the universities and voluntary organisations, will meet the varied educational needs of adolescents and adults. It has already assured local education authorities that it will encourage experiments, stimulate initiative and foster developments. At the same time, it must be recognized that a repetition of past mistakes will only be avoided, and the maximum opportunity afforded to men and women everywhere to achieve maturity of outlook and a richer leisure, if all engaged in further education can share experiences and contribute their own ideas to the common pool. It is this need which *Further Education* hopes to meet. The first number will include articles on the organisation of further education, the problem of the young worker in industry, the future of discussion groups, the art of listening, commentaries on films, music and radio and book reviews. The editor is Mr. John Mackay-Mure. All subscriptions received before April 30 will be accepted at the reduced rate of fifteen shillings per annum.

Blundell's School Science Society

The educational value of school science societies deserves to be more fully appreciated, and their possibilities as training-grounds for young scientific workers merit wider recognition. For not only do the activities of these societies extend beyond the limitations of routine class-room teaching, they provide conditions under which individual interest can arise and develop as a matter of spontaneous, personal growth; and genuine, personal interest is one of the most important factors making for success in science. At the same time, lectures by visiting speakers enable members to come into contact with persons of some eminence in the fields of research and applied science, and so to learn something of their personality, outlook and achievements. Valuable training is also given to those young scientific workers who themselves deliver lectures, write up reports or prepare exhibits. In the field of biology, if such societies do no more than encourage members to extend their basic acquaintance with plant and animal types, they would be serving a useful purpose. Usually, however, a certain amount of more advanced field work is also undertaken. One notes a tendency to concentrate on ecological studies, which, with beginners, do not always yield very clear results, in contrast to such fields of interest as animal behaviour, seed dispersal, population studies, and applied biology, particularly in relation to agriculture, which provide opportunities for promising work by young observers, carried out at odd times and with little apparatus.

The above points come out clearly in the *Magazine of the Science Society of Blundell's School, Tiverton,* to the first number of which we extend a welcome. As its editors, Mr. W. H. Dowdeswell and Dr. M. Ashby, point out, the issue is nearly all taken up with records of biological observations, although the interests of the more exact sciences are not being overlooked. The magazine records the presentation to Blundell's School of the Rippon collection of butterflies and moths, which is rich in local and migrant specimens as well as in unusual, mutant forms. M. A. Lyne contributes a list of butterflies found in the Tiverton area in 1946; the season, however, was late, dull and wet. There is also a report on an expedition by the Society to Winsford Hill, Exmoor, which led to suggestive contrasts between the fauna and flora of moorland country and those found lower down. Of the botanical studies, a survey of the plant communities on areas of chalk, clay and sand, by R. Champion, is of distinct promise, and a similar one on the flora beneath an oak tree canopy, by O. H. D. Portsmouth, is a conscientious piece of work. In his investigation of animal life in a sea pool, both resident and temporary, R. Honey shows a clear grasp of the main ecological factors concerned, and so does C. D. Weeks in his report on the fauna of a swiftly flowing stream. A study of the food of the wood-pigeon in the Camborne–Redruth area, by J. Williams, produces telling evidence of the destructiveness to farm crops of these birds, while a similar study of the food of the stoat and its effects on other animal life in the north-west Mendips, by S. T. G. Butterworth, is interesting, less for the findings which emerge than from the amount of careful observation which he must have put into it. A further paper on weeds on school lawns, by J. C. Newell-Price, extends interest to applied biology, but stops short of detailed discussion of the ecology of weeds or of their eradication. Altogether, these reports bear evidence of original and independent investigations being carried out by young scientific workers in many different fields, well worthy of recognition and encouragement. Blundell's has always enjoyed a good reputation for scientific work and training; its new *Magazine* will certainly enhance this.

X-Ray Diffraction Index for Identification of Materials

THE "Index of X-ray Diffraction Data" and its first Supplement, published by the American Society for Testing Materials, have been of considerable use in many industrial and other laboratories for the identification of unknown substances. The Supplement was based largely on data edited in Great Britain under the auspices of the Institute of Physics. The preparation of another Supplement has now begun, and the co-operation of all who use powder photographs is invited. Although the main purpose of the Supplement will be to include new substances, new data on substances already in the "Index" will be welcomed. Many of the older data were obtained with short X-rays (such as those from molybdenum) or with small-diameter cameras (such as 5·7 cm.), so that in some cases low-order lines were missed, and in others lines of nearly equal spacing were not resolved. New data obtained with longer X-rays (copper or longer) and larger-diameter cameras (9 cm. or more) are very desirable for these substances. X-ray workers who are able to help by supplying data for new substances, or data that they believe to be more reliable for substances already in the "Index", or corrections of mistakes, or references to work published in periodicals that do not enjoy a wide circulation in Great Britain, are invited to communicate with Dr. A. J. C. Wilson, Physics Department, University College, Cardiff.

Research at the Bermuda Biological Station

THE Bermuda Biological Station for Research has received from the American Philosophical Society a grant of 6,000 dollars for the period of three years, 1947–49, to be used for research fellowships at the Station. Applications should be forwarded to Dr. Dugald E. S. Brown, Director, Biological Station, St. George's, Bermuda. Applicants should state the nature of the intended research and the expected length of stay at the Station.

During the next few years the scientific programme of the Station will be centred around the physiology of marine organisms. To this end laboratories of physiology, biochemistry, and biophysics are being constructed and adequate facilities provided for the collection and maintenance of a wide variety of marine organisms. When the reconstruction is completed, seventeen laboratories will be available to investigators and, in addition, several rooms for workers not requiring the usual laboratory facilities. By June of this year there will be living accommodations for twenty-four workers.

Physical Society's Exhibition

THE thirty-first Exhibition of Scientific Instruments and Apparatus, organised by the Physical Society, will be held during April 9–12 at the Imperial College of Science and Technology, London. Discourses will be delivered each evening at 6.15 (and repeated at 8.15 if necessary) as follows: "Recent Infra-red Developments", by Dr. R. Lee (Admiralty Research Laboratory, Teddington); "Automatic and Manual Position Control Systems", by Prof. A. Porter (Military College of Science, Shrivenham); "Recent Advances in Optical Science", by Mr. B. K. Johnson (Imperial College); "Recent Developments in Air Photography", by Mr. G. C. Brock (Royal Aircraft Establishment, South Farnborough). Films will be shown on each of the four days: "Kelvin, Master of Measurement", by permission of Messrs. Kelvin Bottomley and Baird, Ltd., and Marine Instruments, Ltd.; "Applications of Kinematography in Science", by the British Kinematograph Society; "Time-Lapse Photographs of the Whole Sky", by Kodak, Ltd., Research Laboratories; "Phase-contrast Microscopy of the Development of Sperm Cells of the Grasshopper", by Kodak, Ltd., Research Laboratories. On account of the fuel and power situation, it will not be possible to produce the Catalogue in time for the Exhibition; an 8-page list of exhibitors (with stand numbers) will be available, and the full Catalogue will follow in due course. Admission to the Exhibition is by ticket, 10 a.m.–1 p.m. and 2 p.m.–9 p.m. daily.

Conference on Pulverized Fuel

A CONFERENCE covering the preparation and utilization of pulverized fuel has been arranged under the auspices of the Institute of Fuel and will be held at Harrogate during June 3–6. Some fifty papers are being contributed from users, manufacturers and research organisations, and contributions are expected from Australia, France, Holland, Germany, South Africa and the United States. All papers will be available in the form of a book, so that the sessions will be devoted to discussions, following opening surveys by the chairmen, which will be published later with summaries of the discussions. Further particulars can be obtained from the Pulverized Fuel Conference Committee, Institute of Fuel, 18 Devonshire Street, London, W.1.

University of London: Appointments

THE following appointments in the University of London have been announced:

Dr. C. A. Coulson has been appointed to the University chair of theoretical physics tenable at King's College as from October 1, 1947. During 1928–38 he was a fellow of Trinity College, Cambridge, and later senior lecturer in applied mathematics at Dundee. Since 1945 he has been a College lecturer in mathematics at University College, Oxford, and I.C.I. research fellow in chemistry at the Physical Chemical Laboratory, Oxford.

Dr. E. T. C. Spooner has been appointed to the University chair of bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine as from October 1, 1947. Since 1931 he has been demonstrator and afterwards lecturer in pathology at Clare College, Cambridge, of which he is a fellow and tutor. During 1940–43 he worked for the Medical Research Council.

Dr. R. M. S. Thompson has been appointed to the University chair of chemical pathology tenable at Guy's Hospital Medical School as from October 1, 1947. In 1938 he was Gillson research scholar in pathology at the Society of Apothecaries in London, and since that date has been fellow and tutor of University College, Oxford, and demonstrator in biochemistry at Oxford. During the War years he was attached to the Chemical Defence Research Department of the Ministry of Supply.

Dr. H. Grüneberg has been appointed to the University readership in genetics tenable at University College as from October 1, 1946. Since 1938 he has held the Moseley research studentship of the Royal Society.

Dr. J. F. Kirkaldy has been appointed to the University readership in geology tenable at Queen Mary College as from October 1, 1947. During 1929–33 he was demonstrator in geology and geography at King's College; later he was assistant lecturer in geology and geography at University College, after which he returned to King's College and was made lecturer in geology and geography in 1939. In the same year he entered the Meteorological Office, and in 1943 took a commission in the Meteorological Section of the R.A.F.V.R.

The title of reader has been conferred on the following in respect of the posts they already hold: Dr. Charlotte M. Fleming, Institute of Education (education); Dr. B. J. Lloyd Evans, University College (mechanical engineering); Dr. D. W. G. Style, King's College (chemistry).

Agricultural Scholarships

THE Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at university departments of agriculture, or agricultural colleges, for degree or diploma courses, or at veterinary colleges for courses in veterinary science; six extended junior scholarships (for those who have already held junior awards); and sixty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding one year in duration. The scholarships are open to the sons and daughters of agricultural workers and to persons who are themselves *bona fide* workers in agriculture. The method of selection is by interview. Candidates for senior or junior scholarships must have attained the age of 17 and 16 years respectively by September 30, 1947. Full information concerning the scheme and forms of application may be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W.1, or from the education offices of County Councils. The latest date for submitting completed applications is April 30.

Announcements

THE Society of Foresters of Great Britain has presented a medal to Sir Roy Lister Robinson, chairman of the Forestry Commission, in recognition of his outstanding services to British forestry. Sir Roy Robinson was the first president of the Society, and this is the first award of its kind. It has been announced that Sir Roy is retiring from the office of director-general of forestry in Great Britain.

SIR JOHN LENNARD-JONES, Plummer professor of theoretical chemistry in the University of Cambridge and chief scientific adviser to the Ministry of Supply, has been appointed chairman of the Advisory Council on Scientific Research and Technical Development, Ministry of Supply, in succession to Sir Frank Heath, who has retired after serving almost from the inception of the Council early in the War.

DR. E. DELPORTE, director of the Royal Observatory of Belgium, Uccle, and Prof. Carl Störmer, professor of mathematics in the University of Oslo, have been elected *Correspondants* of the Section of Astronomy of the Paris Academy of Sciences.

THE annual general meeting of the Mathematical Association will be held at the Polytechnic, Regent Street, London, during April 9–10. The meeting includes discussions on visual aids in the teaching of mathematics and on a unified course in mathematics in secondary schools.

THE following officers were elected at the annual general meeting of the Royal Photographic Society: *President*, F. J. Tritton; *Vice-Presidents*, Percy W. Harris and L. V. Chilton. *Ordinary Members of Council*, Marcus Adams, J. Allan Cash, R. J. Cox, R. N. Haile, R. C. L. Herdson, T. Midgley Illingworth, J. D. Johnston, S. D. Jouhar, Mrs. R. Maingot, H. S. Newcombe, Anthony Peacock, Oliver G. Pike, S. Schofield, D. A. Spencer and G. C. Weston.

THE following have been elected officers for 1947 of the Royal Society of South Africa: *President*, Prof. R. S. Adamson, professor of botany in the University of Cape Town; *Secretary*, A. J. H. Goodwin, University of Cape Town; *Treasurer*, J. G. Rose; *Editor*, Dr. A. L. du Toit; *Librarian*, Dr. E. Newbery; *Members of Council*, Prof. M. R. Drennan, Dr. P. J. du Toit, W. E. Isaac, Dr. J. Jackson, Prof. R. W. James, R. F. Lawrence, Dr. J. V. L. Rennie, Prof. B. F. J. Schonland, Prof. F. Walker, C. L. Wicht.

THE first edition of "British Chemicals and their Manufacturers" to be published after 1939 was issued by the Association of Chemical Manufacturers, 166 Piccadilly, London, W.1, in November 1946. This includes up-to-date information on the manufacturers of all types of chemicals, and also covers the publication "Directory of British Fine Chemicals" (1940), which is merged in the present single volume. A copy will be sent gratis to any *bona fide* inquirer, on application to the Association.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Plant Carbonic Anhydrase

In contrast to the wealth of information concerning carbonic anhydrase in the animal kingdom, there have been few reports of the occurrence of this enzyme in the plant kingdom[1]. It seemed desirable, therefore, briefly to describe the following observations made in the course of work on the enzyme in animal tissues.

Activity tests carried out on aqueous extracts by means of the boat method[2] have revealed a widespread occurrence of carbonic anhydrase in the leaves of flowering plants, including, for example, all cultivated Brassicas, wallflower, peach, cucumber, grapefruit, spinach, *Bunias orientale, Stellaria media, Melilotus altissima* and *Chenopodium album*. Roots of those species investigated showed no carbonic anhydrase, though a small but distinct activity was found in extracts of nodules of French beans (as well as in the leaves). There were also numerous species in which no activity could be detected in the leaves. However, in several of these apparently negative cases, for example lettuce, potato and sugar beet, carbonic anhydrase could be clearly demonstrated when the leaves were ground and extracted with dilute (0·01 *M*) solutions of cysteine (sugar beet, Fig. 1). Moreover, many of the plants which yielded active aqueous extracts showed higher activity when extracted with cysteine solutions (*Tropæolum*, Fig. 1).

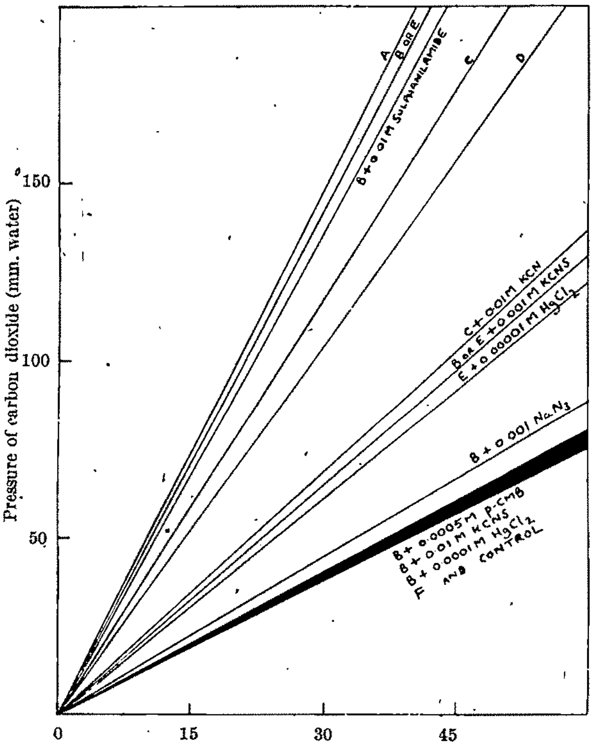


Fig. 1. Rate of output of carbon dioxide at 4·5° C. after mixing 2 ml. bicarbonate solution and 2 ml. phosphate buffer alone (control), and in presence of 0·2 ml. of various leaf extracts (*A, B, C, D, E, F*), showing the effect of several inhibitors (*p*-CMB = *p*-chloromercuribenzoate). 2 gm. of fresh leaf were ground and the suspension filtered to give 10 ml. extract; *A, Tropæolum majus*, 0·01 *M* cysteine extract, and *C*, aqueous extract; *B*, grapefruit, aqueous extract; *D*, sugar beet, cysteine extract, and *F*, aqueous extract; *E*, parsley, aqueous extract

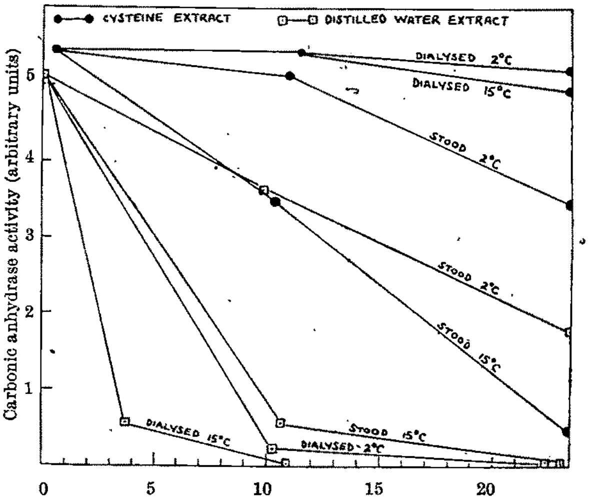


Fig. 2. Effect of ageing and dialysis at 2° C. and 15° C. on carbonic anhydrase activity of leaf extracts of *Tropæolum majus*; aqueous extracts dialysed against glass-distilled water, 0·01 *M* cysteine extracts dialysed against 0·01 *M* cysteine

Generally on standing or on dialysis the aqueous extracts lost enzyme activity quite rapidly; but in *Tropæolum*, for example, cysteine extracts showed only very slight loss after standing for 24 hours at 2° C. or after dialysis against cysteine under these conditions (Fig. 2). This seems to indicate a much greater dependence on SH groups than is the case in animal carbonic anhydrase. Further evidence for this conclusion comes from the fact that 0·0005 *M* *p*-chloromercuribenzoate or iodosobenzoate, regarded as fairly specific SH inactivators, inhibit the plant enzyme in whole leaf extracts more strongly than they inhibit the animal enzyme in highly purified solution. On the other hand, both are strongly inhibited by mercuric chloride, a less specific reagent.

Apart from more marked SH requirements, plant carbonic anhydrase differs from the animal enzyme in several respects: (*a*) The activity in plant sources is generally lower than that in animal sources, an average figure being 1 E.U. per 20 mgm. fresh leaf (determined at 15° C.) compared with 1 E.U. per c.mm. ox blood[2]. (*b*) Sulphanilamide, a specific inhibitor of animal carbonic anhydrase[3], has little or no effect on the leaf enzyme; yet it will completely inhibit animal carbonic anhydrase added to the leaf extracts. A small anhydrase activity observed in intact cells from two cultures of *Chlorella* was, however, completely inhibited by 0·0005 *M* sulphanilamide. (*c*) Cyanide and azide inhibit the plant enzyme, but only in rather high concentrations; thiocyanate inhibits the two enzymes to an approximately equal extent. It must be remembered, however, that comparisons have been made between whole leaf extracts and purified solutions of animal carbonic anhydrase. In all cases the enzyme activity was destroyed after two minutes in a boiling water bath.

All attempts to study the distribution of the plant enzyme in the cell have indicated that, at least in leaf extracts, carbonic anhydrase is absent from the chloroplasts. The latter were separated by centrifugation from glucose-phosphate-buffer extracts and then either re-suspended in glucose buffer where most remained intact, or else re-suspended in distilled water and violently pounded so that most of them disintegrated. In neither case was carbonic anhydrase activity observed in the re-suspension, and the activity of the supernatant liquid after the first spin was the same as that of the uncentrifuged extract.

Finally, it is interesting to note that the list of plants at present known to contain carbonic anhydrase activity includes several—grapefruit, peach, tomato—which are subject to diseases such as mottle-leaf and little-leaf, now attributed to zinc deficiency. If, like animal carbonic anhydrase[4], the plant enzyme is shown to contain zinc, it will be interesting to examine the anhydrase content of zinc-deficient plants.

I am much indebted to Dr. T. Mann for a highly purified solution of animal carbonic anhydrase, and to him, Prof. F. J. W. Roughton, Dr. R. Hill and Mr. F. R. Whatley for advice and assistance.

J. R. G. BRADFIELD

Department of Zoology,
Cambridge.
Feb. 14.

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Elaboration of Hydrochloric Acid by Gastric Mucosa

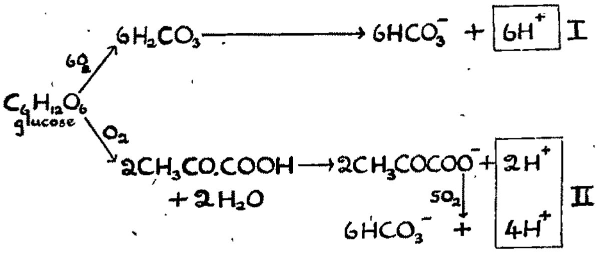
THE experiments the results of which are indicated below were designed to throw light on the mechanism of hydrochloric acid production in the stomach. In order to evaluate a theory of gastric acid elaboration, it is necessary to know the relative magnitude of the Q_{O_2}, Q_{CO_2} and Q_{HCl} of the mucosa and of the oxyntic cells. The maximum $|Q_{O_2}|$ observed in 144 isolated frog gastric mucosæ was 4 µl./mgm. dry wt./hr.[1]; the maximum Q_{HCl} observed in 139 mucosæ was 8 µl./mgm. dry wt./hr.[2]. (Conway and Brady[3] have misquoted our results[4], stating "when Q_{HCl} exceeded twice Q_{O_2}, with the mucosal sack immersed in bicarbonate saline, the tissue appeared damaged". In fact it was stated that the tissue was undamaged, and no claim was made that the Q_{HCl} exceeded twice $|Q_{O_2}|$[4]. Also on p. 137, three lines from bottom, "their Department" should read "our Department".)

The oxyntic cells are the only gastric cells which secrete hydrochloric acid, and they represent about one tenth of the total volume of the mucosa[1]. Thus as all the cells respire, the Q_{HCl} for maximally secreting oxyntic cells must be much greater than $|Q_{O_2}|$. This is confirmed by calculations[1] utilizing the results of Gray, Adkison and Zelle[5] (on frogs), Teorell[6] (on cats), Ni and Lim[7] and Hanke[8] (on dogs). The figures for human gastric mucosa give Q_{HCl} values between 50 and 100. Rosenthal and Lasnitzki[9] found that the Q_{O_2} of eleven samples of isolated human gastric mucosa lay between -5 and -20. It is thus clear that in the frog, cat, dog and man, the Q_{HCl} of oxyntic cells can be very much higher than $|Q_{O_2}|$.

When hydrochloric acid is secreted by oxyntic cells into the gastric tubules, an exactly equivalent amount of alkali is also produced. In the presence of carbon dioxide, virtually all this alkali is converted into bicarbonate ions and is secreted into the nutrient or organism side of the gastric mucosa[10,8,11]. Maximally secreting oxyntic cells with any possible respiratory quotient cannot provide sufficient carbon dioxide from their own metabolism to neutralize this alkali formed concomitantly with the acid. Therefore, the actively secreting stomach must utilize carbon dioxide extracted from the blood or surrounding tissues. At high rates of secretion, the rate of uncatalysed carbon dioxide uptake is quite insufficient to neutralize the alkali[1]. There is, however, enough carbonic anhydrase in cat oxyntic cells to magnify this rate of carbon dioxide uptake about 70,000 times[12,1], and it is probable that the failures of Feldberg, Keilin and Mann[13] and of Davenport[14] to inhibit acid secretion using carbonic anhydrase inhibitors were due to residual uninhibited enzyme. A magnification only of the order of a hundredfold is required, and this can be produced even if about 99·9 per cent of the enzyme is inhibited.

The suggestion of Conway and co-workers[15,3] that carbonic anhydrase accelerates the production of carbon dioxide, which the cell then excretes, seems most unlikely in view of Gray's comments[16] on the occurrence of a reversed chloride shift in blood passing through a secreting stomach.

Our evidence is contrary to the theories of Bull and Gray[17] and of Conway and co-workers[15,3], who postulated that the hydrogen ions come from acids such as pyruvic, succinic or carbonic formed from glucose during respiration. In the first two cases, the Q_{HCl} cannot be greater than one third $|Q_{O_2}|$[4]; in the last the Q_{HCl} cannot be greater than $|Q_{O_2}|$. Such mechanisms cannot produce more than six hydrogen ions when six molecules of oxygen react with one molecule of glucose; so Conway's statement that the hydrogen ions from an organic acid may supplement those from carbonic acid, or that a cyclical process[3] could give a Q_{HCl} far higher than Q_{O_2}, is not justified. Moreover, the aerobic glycolysis of gastric mucosa is slow compared with the respiration[9,1]. These facts rule out theories dependent upon the production of hydrogen ions by the fermentation or oxidative degradation of any carbon compound.


$6H_2CO_3 \longrightarrow 6HCO_3^- + \boxed{6H^+}$ I
$6O_2$
$C_6H_{12}O_6$
glucose
O_2
$2CH_3CO.COOH \longrightarrow 2CH_3COCOO^- + 2H^+$
$+ 2H_2O$
$5O_2$
$6HCO_3^- + 4H^+$
II

TWO RECENTLY SUGGESTED MECHANISMS PRODUCING HYDROGEN IONS FROM GLUCOSE OXIDATION

The insufficiency of chemical mechanisms of this type led us to investigate the possibility of a physico-chemical mechanism[18]. Since 1859 [19], there has been sporadic speculation as to the existence of a causal relation between the electric potential difference which exists across the gastric mucosa and the secretion of hydrochloric acid[20,21]. We have obtained the following results using isolated frog gastric mucosa[18,2]; they are comparable with those obtained by Rehm using live dogs[21].

(1) The secretory side of the mucosa was negative (in an external circuit) with respect to the nutrient side in all of 133 mucosa. The potential difference across reactive mucosæ was 20–50 mV.

(2) When acid secretion commenced, either spontaneously or induced by histamine, the magnitude of the potential difference decreased sharply by

10–20 mV., this decrease being greater for high secretion-rates than for low ones. At the end of secretion, whether spontaneous or due to the addition of sodium thiocyanate, the potential difference rose again.

(3) On no occasion during a total of 127 experiments was acid secretion or a potential difference observed in the absence of respiration produced by anoxia or respiratory inhibitors.

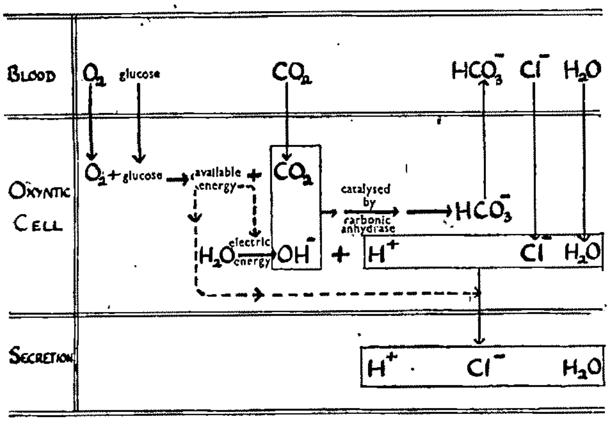
(4) When the two sides of the mucosa were connected electrically through a low resistance, a steady current was maintained, representing an expenditure of power by the mucosa of nearly 1 μ watt/mgm. dry wt.

(5) When an electric current of the order of 1 ma./cm.^{2} from an external source was passed through an acid-secreting mucosa in such a direction as to enhance its natural potential difference, the Q_{HCl} was increased by an amount up to 1·2 ± 0·1 μl./mgm. dry wt./hr. The same current opposing the natural potential difference inhibited the rate of acid secretion by an amount up to 2·8 ± 0·1 μl./mgm. dry wt./hr. When the same or even a much greater current was passed in either direction through œsophageal, pyloric, duodenal or rectal mucosa, frog skin, 'Cellophane', or dead gastric mucosa, no trace of acid was detected. Up to 5 ma./cm.^{2} passed through live gastric mucosæ, in which no acid secretion could be induced even by histamine, produced no detectable amount of acid; that is, the Q_{HCl} was less than 10^{-4}.

On the basis of these results, we suggest that the reaction fundamentally concerned in the production of hydrochloric acid in gastric mucosa is that which occurs when the cell

$$\text{hydrogen} \;\Big|\; OH^- \text{ aq.} \,\vdots\, H^+ \text{ aq.} \;\Big|\; \text{hydrogen}$$

is reversed by an external source of power. The reaction for one faraday is $H_2O = OH^- + H^+$.



SUGGESTED OVERALL REACTION ELABORATING HYDROCHLORIC ACID IN GASTRIC MUCOSA

The accompanying scheme suggests how the hydrogen ions are normally elaborated by means of energy available from glucose metabolism, and the hydroxyl ions finally neutralized by carbon dioxide from internal and external sources, and passed into the blood.

The experimental results that acid secretion is accompanied by a change in the potential difference across the mucosa, and that the rate of secretion is affected when this potential difference is changed by supplying electric power to the mucosa, suggest that electric power plays an important part in the mechanism of hydrochloric acid elaboration by gastric mucosa.

A full account of our experiments will be submitted to the *Biochemical Journal*.

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Serum Chlorides in Pregnant Mice

DURING previous work on the serum chlorides of agouti and non-agouti mice, it was noted that pregnant mice usually gave lower results than non-pregnant. This has been investigated, using the technique previously described[1]. Estimations were made at the tenth day of pregnancy, as judged by the date of the vaginal plug and checked by the age of the embryos[2]. It is considered that the limits of departure from this date did not exceed 24 hr. All females were placed with the male at the age of eight weeks. They did not all become pregnant on the same day, due to variations in their œstrus cycles, so that there were differences in the ages at which the estimations were made, the greatest being four days. No relationship between these differences in age, either in pregnant or non-pregnant mice, and the chloride levels has been found. Controls were non-pregnant mice from the same litters at the same ages.

The accompanying table shows the results obtained expressed as milli-equivalents of chloride per litre of serum. The figures in brackets after the values for the pregnant mice indicate the number of embryos present.

Pregnant	Non-pregnant	Pregnant	Non-pregnant
128 (7)	130	120 (7)	121
122 (8)	133	120 (7)	126
122 (10)	127	120 (7)	133
116 (6)	131	117 (9)	122
115 (10)	123	120 (11)	122
117 (6)	128	117 (11)	129
117 (9)	124	120 (10)	122
114 (7)	134	118 (8)	131

The means for the two series were pregnant 119, non-pregnant 127. Estimation of the significance of the difference between these means was made[3] giving $t = 6\cdot114$ for $n = 30$. The limit of the published tables[4] is $P = 0\cdot001$, $t = 3\cdot646$ for $n = 30$. The difference is therefore highly significant, P being less than $0\cdot001$, and the definite statement may be made that there is a decrease in the serum chloride concentration in mice during pregnancy. There is no correlation between the serum chloride level and litter size.

The explanation of this decrease is at present obscure. There are many facts and theories which may be relevant, the following being considered to be the most obvious: the increase in salt appetite during pregnancy[5]; the relation of the ovaries to salt metabolism[6]; the effect of pregnancy on adrenalectomized animals[7]: the beneficial effect of restriction of salt intake on the toxæmia of pregnancy is well known; the theory that the fœtal adrenal cortices are active[8]; the hyperpigmentation of normal pregnancy; the influence of sodium chloride on melanin formation[9]. A working hypothesis has been formed from these and other statements; but there is in sufficient critical evidence to justify its publication at this stage. An attempt is being made to obtain the necessary evidence.

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Microdetermination of Copper in Biological Substances

In the course of a series of investigations by F. Buscarons and E. Loriente[1,2] on analytical applications of 3,3′, 4,4′-diamine-3,3′-dimethoxy-biphenilo (*o*-dianisidin), these authors have shown that this substance in certain conditions possesses extreme sensitivity for cupric copper. We have used this reactant for colorimetric determinations of copper in the blood and in other biological substances.

The mechanism of the reaction is based in the green coloration that occurs when solutions containing cupric copper are treated with an acetic solution of orthodianisidin and afterwards with a slight excess of sulphocyanide. This coloration tends to change to yellow when the concentrations of copper are around $1/10^6$; if the concentration is greater than $1/5.10^5$ much blue precipitate is produced.

For the determination of the copper in small quantities it is necessary to purify all the reactants and use twice-distilled water in a glass apparatus; glass or porcelain burners should be used, because brass ones easily pollute the atmosphere. We use the wet method of analysis because by the dry method volatile copper products are easily formed. Nitro-perchloric acid is used, warming until the liquid is decolorized and there are plenty of fumes of perchloric acid. To eliminate the ferric iron which with the dianisidin gives a red coloration, we precipitate the copper as sulphide; and to help this precipitation, and to make the precipitate easier to handle, before passing the current of hydrogen sulphide through the solution we add a small quantity of 4 per cent lead acetate solution (dianisidin gives no colour with lead, at least in the conditions in which we work).

The precipitate is centrifuged and washed; it is then dissolved in some drops of nitric acid and evaporated to dryness on a bath at 150° in order to eliminate the nitric acid. The residue is dissolved with water, and to this aqueous solution we add a few drops of a freshly prepared and colourless acetic solution of dianisidin, and then ammonium sulphocyanide in a light excess, plus one third of the volume of the solution of ethyl alcohol. A green coloration is produced if copper is present; with quantities of copper less than a gamma per c.c. the colour turns yellow in 10–20 min. and remains at least two hours. This colour is compared colorimetrically with that produced by a standard solution of copper with a concentration similar to that suspected in the sample to be analysed and treated in the same way.

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Vicinal Action in Steroids

The optical rotatory powers of steroidal compounds can be correlated by means of the method of molecular rotation differences, and such correlation has been shown to be of value in solving certain types of structural problem[1]. In some cases anomalies of optical rotatory power occur which cannot be ascribed to trivial causes, but which must be due to disturbing factors generally given the name 'vicinal action'.

It has been assumed that the forces responsible for vicinal action decrease with distance and must become inoperative beyond a certain point[3]; the magnitude of vicinal action may be represented by the expression $\Delta\,\Delta$ value as used in Tables 1 and 2. The fused-ring structure peculiar to steroids, together with other factors, makes these compounds particularly suited to the study of the variation of vicinal action with distance, and, accordingly selected examples have been examined from this point of view. Tables 1 and 2 refer to a number of compounds which have been prepared in a state of special purity and for which rotation measurements have been made in chloroform solution for the sodium D line. Specific rotations have been rounded off to the nearest degree in calculating the molecular rotations so that, in the absence of vicinal action, Δ_1, Δ_2 and Δ_3 values (see Tables 1 and 2) should agree with the corresponding standard values for cholesterol and cholestanol to at best ± 4.

TABLE 1

Substance	$[M]_D$ Alc.*	Ac.†	Bz.**	Δ_1	Δ_2	$\Delta\Delta_1$	$\Delta\Delta_2$
Cholesterol (standard values)	−154	−188	−74	−34	+80	—	—
$\Delta^{5,22}$-Stigmastadien-3(β)ol	−210	−250	−134	−40	+76	−6	−4
Δ^{5}-Androsten-17-one-3(β)ol	+6	−23	+94	−29	+88	+5	+8
17-Methyl-Δ^{5}-androsten-3(β) : 17(α)diol	−258	−294	—	−36	—	−2	—
Δ^{5}-Androsten-3(β) : 17(α)-diol 17-benzoate	−16	−48	+65	−32	+81	+2	+1
Cholestanol (standard values)	+89	+60	+94	−29	+5	—	—
$\Delta^{7,22}$-Ergostadien-3(β)ol	−76	−88	−50	−12	+26	+17	+21
Δ^{7}-Ergosten-3(β)ol	−10	−18	+10	−8	+20	+21	+15
$\Delta^{8(14)}$-Ergosten-3(β)ol	+44	+4	±0	−40	−44	−11	−49
Δ^{14}-Ergosten-3(β)ol	+88	+58	+116	−30	+28	−1	+23
Cholestan-6-one-3(β)ol	−24	−71	+20	−47	+44	−18	+39
Cholestan-7-one-3(β)ol	−144	−163	−86	−19	+58	+10	+53
Androstan-17-one-3(β)ol	+261	+229	+272	−32	+11	−3	+6
Allopregnan-20-one-3(β)ol	+305	+277	+319	−28	+14	+1	+9
$\Delta^{8(9),14}$-Ergostadien-3(β)ol	−76	−158	−15	−82	+61	−53	+56

* Alcohol. † Acetate. ** Benzoate.

TABLE 2

Substance	$[M]_D$ Alcohol	Ketone*	Δ_3	$\Delta\Delta_3$
Cholesterol (standard values)	−154	+357	+511	—
Δ^{5}-Androsten-3(β) : 17(α)diol	−183	+340	+523	+12
17-Methyl-Δ^{5}-androsten-3(β) : 17(α)-diol	−258	+257	+515	+4
$\Delta^{5,22}$-Stigmastadien-3(β)ol	−210	+258	+468	−43
Δ^{5}-Androsten-17-one-3(β)ol	+6	+572	+566	+55
Δ^{5}-Pregnen-20-one-3(β)ol	+79	+631	+552	+41
Δ^{5}-Androsten-3(β) : 17(α)diol 17-benzoate	−16	+615	+631	+120
Cholestanol (standard values)	+89	+162	+73	—
Cholestan-6-one-3(β)ol	−24	+16	+40	−33
Cholestan-7-one-3(β)ol	−144	−76	+68	−5
Androstan-17-one-3(β)ol	+261	+325	+64	−9
Allopregnan-20-one-3(β)ol	+305	+382	+77	+4

* Δ^{4}-3-Ketones when from Δ^{5}-stenols.

The variation of vicinal action with distance can be assessed by the series of ketones where the carbonyl group is removed progressively further from the 3-position, and by the series of unsaturated sterols where the double bond is similarly removed progressively to a more remote position relative to the hydroxyl group. Inspection of Tables 1 and 2 reveals that in the series of carbonyl compounds vicinal action does indeed decrease with increase of distance. The same general effect is to be noted in the series of unsaturated sterols, although the decrease of vicinal action with distance is by no means regular. In general, the magnitude of the Δ Δ values depends on the particular transformation under consideration at the 3-position, being usually small for acetates and saturated ketones, but large for benzoates and Δ^{4}-3-ketones, and also upon the nature and position of the variable substituent placed elsewhere in the molecule.

Considering, for the moment, molecules retaining unaltered the configurations of cholesterol and cholestanol and their simple functional derivatives in rings *A* and *B*, which have substituents in rings *C* and *D* or in the side-chain, certain generalizations can be made regarding the incidence of vicinal action. Without doubt anomalies only occur in those cases where two easily polarized groups are present, and it is shown that vicinal action can in certain cases be transmitted from the side-chain to the 3-position, a distance of more than 10 A. There is, however, an additional requirement besides that of polarizability, which would seem to depend upon the capacity of the substituent groups for distorting the molecular framework.

Still considering steroid molecules substituted as mentioned above, it is possible to classify substituent groups into three classes, as indicated below, in the third of which are placed those groups which are specially to be expected to distort the framework of the molecule. Clearly, there is no rigid dividing line between the groups placed in classes 2 and 3, and to a considerable extent the incidence of vicinal action must depend upon the actual position of the groupings in the molecule. The ethylenic linkage must be placed in both classes 2 and 3, although molecules containing two ethylenic linkages, one in the side-chain and the other in the steroidal nucleus, do not exhibit large optical anomalies.

(1) No anomalies in molecular rotation, C—H, C—C, C—OH.

(2) Anomalies only in the presence of class 3 substituents, C—O.CO.CH_3, C—O.CO.C_6H_5, C=O, C=C.

(3) Causing anomalies if another member of classes 2 or 3 be present, C=C, C=C—C=O, C=C—C=C.

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[2] Compare Wallis *et al.*, loc. cit.

Gamma-Radiation from Polonium and from Lithium Bombarded with Alpha-Particles

IN connexion with the study of the secondary radiation emitted when a number of light elements were subjected in turn to the alpha-radiation emitted by a strong sample of polonium, Bothe and Becker[1] found that polonium also emitted a hard gamma-radiation. The intensity of this was low, about one gamma-quantum being emitted for 10^5 alpha-particles. The gamma-radiation of polonium was interpreted as resulting from the fact that one of 10^5 alpha-particles was emitted with a lower energy than the rest, leaving the nucleus in an excited state, from which it returned to the ground-state with emission of a gamma-quantum. This gamma-quantum is able in its turn to release an electron from the new nucleus (RaG = Pb^{206}) or the electron shell of nearby atoms, thus causing a secondary beta-radiation. Bothe[2] investigated this beta-radiation with the aid of a beta-spectrograph of high light intensity (semi-circular method).

The beta-spectrum obtained by Bothe shows three 'certain' and two 'uncertain' maxima. The five maxima were thought to be due to gamma-lines with the energies 202 (355), (433) 798, and 1,068 keV. (values corresponding to uncertain maxima are in brackets).

The interpretation referred to above of the gamma-radiation from polonium requires a fine structure in the alpha-particles. Rosenblum[12], and Rutherford and co-workers[14], sought for this in vain. By the use of a large, magnetic alpha-spectrograph, Chang[4] recently succeeded in finding quite a complicated fine structure, consisting of twelve different ranges apart from the maximum. The yet unconfirmed results of Chang have been discussed by Feather[5].

In another investigation, Bothe[3] studied the secondary beta-spectra due to the gamma-radiation from some lighter nuclei which were excited by alpha-particles from polonium. Here the polonium, as the only gamma-radiating substance, was enclosed in a lead capsule with walls 0·6–1 mm. thick. In this manner a Compton- and photo-spectrum was obtained the structure of which was rather monotonous and did not offer any safe foundation for a determination of the energy of the gamma-radiation. The curve was used for ascertaining the background which had to be deduced in order to get the Compton- and photo-spectrum of the gamma-radiation from the processes they released, when lithium, fluorine and beryllium in turn were bombarded with alpha-particles from polonium. As regards the spectrum of lithium, Bothe considered that this consisted practically only of photo-electrons, and that the appearance of the spectrum permitted the determination of two certain bands and a faint one, which were denoted as "weit weniger sicher". The energies of the gamma-lines were estimated as 0·59, 0·39 and (0·2) MeV. respectively. According to Bothe, it is here a question of excitation of the more common Li^7-nucleus without capturing the alpha-particle.

If Bothe's interpretation of the gamma-radiation as being due to the excited Li^7-nucleus is correct, this should be capable of confirmation also by investigation of the proton or alpha-particle ranges from the reactions $\mathrm{Li}^6(dp)\mathrm{Li}^7$, $\mathrm{Li}^6(dp)\mathrm{Li}^{7*}$, $\mathrm{B}^{10}(n\alpha)\mathrm{Li}^7$ or $\mathrm{Be}^9(d\alpha)\mathrm{Li}^7$ [13,18,10,7,9,6].

The energy in the gamma-radiation from Li^{7*} can, ultimately, be obtained by the study of Be^7, which with a half-life of 53 days[8] by *K*-capture passes into the ground-state of Li^7, in such a way that 10 per cent of the disintegration leads to Li^{7*}, the remaining 90 per cent into the ground-state Li^7. When the former nucleus passes into its ground-state, there is emitted a gamma-quantum of just the energy which is of interest in our work. One of us[16] investigated the photo-effect released in lead-foil by means of a magnetic lens spectrograph, and obtained from the well-marked *K*- and *L*-photo lines for the energy of the gamma-radiation the same value, 453 keV.

Only Bothe has found several components in the gamma-radiation from Li^{7*} as well as from polonium. It therefore seemed to us[17] desirable to test these results by making use of the reliable method of investigating the photo- and Compton-effect in lead in the magnetic lens spectrograph[15].

In a small cylindrical platinum dish with an outside diameter of 8 mm., a height of 2 mm. and a depth of 1 mm. (thickness of metal 1 mm.), there was evaporated drop after drop of a solution of polonium chloride (86 mC.). The platinum dish was then introduced into a cylindrical lead radiator, after which the radiator was closed with a lead cylinder, which was soldered fast in the radiator with the aid of Wood's metal. The gamma-radiation from platinum released in the 0·5 mm. thick bottom of the radiator photo- and Compton-electrons, the energy of which was determined by use of the spectrograph. For excitation of lithium nuclei a similar radiator was used as for the polonium, the only difference being that a layer of metallic lithium of 0·5 mm. thickness was applied to the bottom of the radiator.

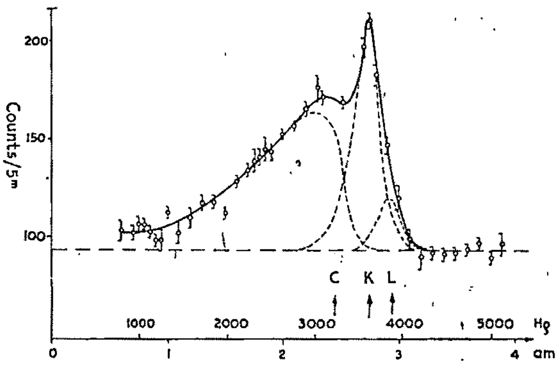

Fig. 1. PHOTO- AND COMPTON-ELECTRON SPECTRUM OF THE GAMMA-RADIATION FROM POLONIUM IN A LEAD RADIATOR

Fig. 1 shows the photo- and Compton-spectrum obtained from polonium in the lead radiator. The curve was prepared as a mean value of sixteen series of measurements. It is possible to notice a well-marked photo-line *K* with a half-value width, which corresponds to the resolving power of the apparatus. From the $H\rho$-value 3610 there is obtained for the beta-energy the value 0·685 MeV. When the ionization work of the *K*-electrons in lead (0·088 MeV.) is added to this value, we get the energy 0·773 MeV. of the corresponding gamma-line.

In Fig. 1 arrows at *C* and *L* mark also the positions of the Compton-edge and the *L*-photo line, which give the same energy of 0·773 MeV. for the gamma-radiation studied, while dotted curves give the three components, corresponding to the Compton-, *K*-photo- and *L*-photo-electrons, into which the experimental curve can be resolved.

The curve shows that the gamma-radiation from polonium is mono-energetic, in contradistinction to the result obtained by Bothe. Bothe's value for the energy in the strongest photo-line, 0·798, agrees well with ours.

If a gamma-radiation of any other energy than 0·773 MeV. is emitted from polonium, it is at any rate extremely weak in comparison with the 0·773 radiation. It must therefore be noted as a remarkable circumstance that, in the fine structure found by Chang in the alpha-particles among the twelve satellite groups, there is not noted any group that is distinguished by specially high intensity or

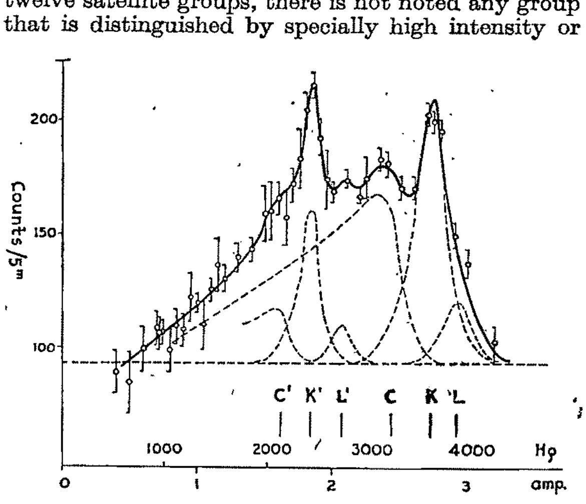

Fig. 2. PHOTO- AND COMPTON-ELECTRON SPECTRUM OF THE GAMMA-RADIATION FROM LITHIUM (IN A LEAD-RADIATOR), WHICH WAS BOMBARDED WITH ALPHA-PARTICLES FROM POLONIUM, AS WELL AS THE GAMMA-RADIATION FROM POLONIUM

by the difference in energy as compared with the main group at 0·773 MeV.

The photo- and Compton-spectrum of the lithium sample was investigated in the same manner as above. Fig. 2 shows the result. We recognize the C, K and L structure just described in the spectrum of polonium. On this has been superimposed the photo- and Compton-electrons denoted respectively by K', L' and C', released by the gamma-radiation from lithium. From the K-line we get $H\rho = 2430$, or an electron energy of 0·374, from which for the lithium gamma-radiation we get the value 0·462 MeV. The L'-line gives 0·471 MeV., and the Compton edge position C' has been drawn in such a way that the corresponding gamma-energy is equal to that which is obtained from the K'-line, which, of course, gives the most reliable result. In Fig. 2 the dotted curves indicate those components into which the experimentally obtained curve (mean of nine series) can be resolved.

The result shows that the lithium nucleus sends out only one kind of gamma-quantum, and that their energy is 0·462 MeV. That Bothe believed he had found a line at 0·39 MeV. was clearly due to his interpretation of the Compton electrons due to 0·462 MeV. radiation as photo-electrons released by some other gamma-radiation. This condition of affairs shows that the Compton-electrons in the gamma-energy dealt with are not negligible.

The value of the gamma-radiation energy, 0·462 MeV., is within the limits of error identical with the value 0·453 MeV., which one of us[16] has found for the radiation from Be^7, and thus constitutes a confirmation of the last-mentioned measurement, and also of the conception regarding the origin of the gamma-radiation, namely, the transition of the excited Li^{7*}-nucleus to the ground-state Li^7. There is thus confirmed here likewise the hypothesis of excitation of the Li^7-nucleus by inelastic collisions with the alpha-particles from polonium and of the K-capture by Be^7.

The value 0·462 MeV. also agrees very well with the values for the energy of the gamma-radiation from Li^7, which was obtained by Rumbaugh *et al.* as well as Hudson *et al.*

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Interaction of Fast Neutrons with Beryllium and Aluminium

THE total cross-sections for the scattering of fast neutrons of known energy by a number of light elements have recently been published[1,2]. The results for the elements carbon and oxygen show resonances at certain values of the neutron energy, and these resonances are ascribed to energy-levels in the compound nucleus formed in the scattering process. Similar resonances in (n,α) transmutations produced by fast neutrons have been known for some time[3,4], but no case has yet been reported in which both the total neutron cross-section and the (n,α) transmutation cross-section for a given element have been shown to involve the same level of the compound nucleus. We have been able to demonstrate this in the case of beryllium, which when bombarded by fast neutrons can yield $^6\mathrm{He}$ in accordance with the reaction[5]

$$ {}^{9}\mathrm{Be} + {}^{1}n \rightarrow {}^{10}\mathrm{Be} \rightarrow {}^{6}\mathrm{He} + {}^{4}\mathrm{He} - 0\cdot8\,\mathrm{MeV}. \quad (1) $$

The total neutron cross-section for beryllium was measured by the transmission method used by other workers[1,2,6]; D + D and C + D neutron sources were used. The observed total cross-section, corrected for inhomogeneity of the incident neutrons, is plotted against neutron energy in Fig. 1 and shows a resonance at 2·6 MeV. The results of other workers[7,8,9] are also plotted in this figure, and taken together with the present results may indicate a further resonance at 0·55 MeV. The (n,α) transmutation cross-section was measured over the same range of neutron energies above its threshold as the total cross-section by observing the 0·86 sec. $^6\mathrm{He}$ β-activity induced by the neutrons in a beryllium-walled Geiger counter. The results of these measurements are

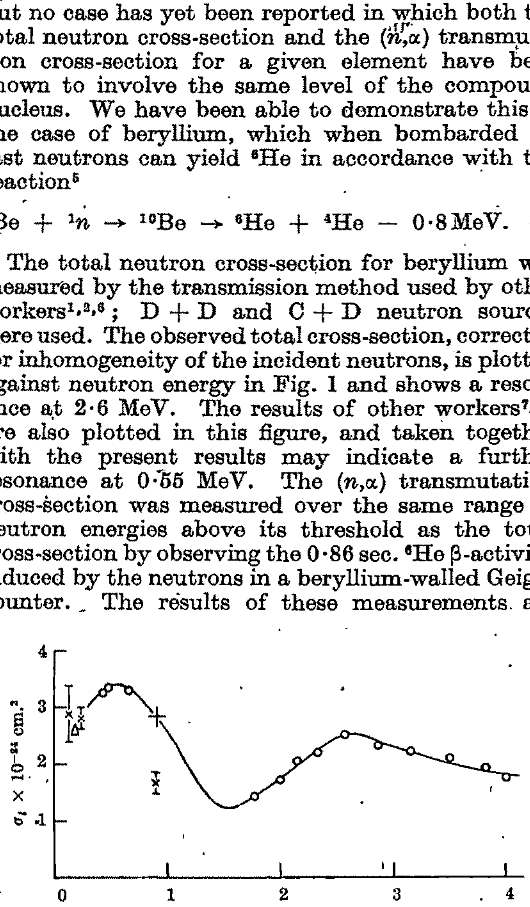

Fig. 1. TOTAL NEUTRON CROSS-SECTION (σ_t) OF BERYLLIUM. CIRCLES ARE THE PRESENT RESULTS; OTHER POINTS ARE DUE TO PREVIOUS WORKERS (REFS. 7, 8, 9)

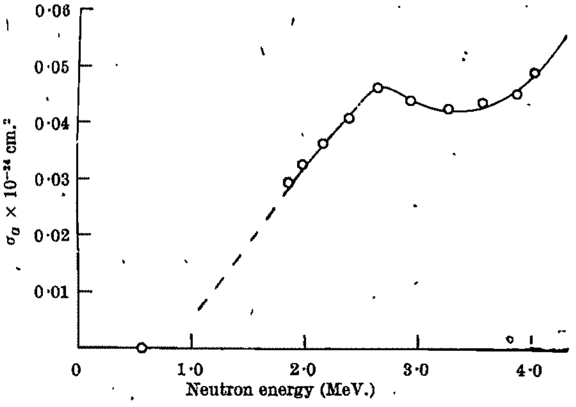

Fig. 2. CROSS-SECTION (σ_a) FOR THE REACTION $^9\mathrm{Be}$ (n,α) $^6\mathrm{He}$

shown in Fig. 2, from which it is clear that a resonance in the (n,α) reaction also occurs at 2·6 MeV.

If it is assumed that the interaction of a 2·6 MeV. neutron with the beryllium nucleus can be considered as analogous to a slow neutron process, the procedure given by Bethe[10] can be applied to show that the width of the level in the ^{10}Be nucleus responsible for the resonant scattering is between 0·8 and 1·0 MeV. This corresponds to a life-time of the ^{10}Be nucleus in this excited state of about 10^{-21} sec., which is longer than the time necessary for a 2·6 MeV. neutron to cross a ^{9}Be nucleus and is, therefore, some evidence for the formation of a compound state in the scattering process. The ratio of the (n,α) transmutation cross-section to the total cross-section at 2·6 MeV. is about 1/50; this is of the same order as the penetrability of the potential barrier of a light nucleus like ^{6}He for an α-particle of the energy available according to (1).

Some of the measurements on beryllium were made with a beryllium–aluminium alloy of known composition, and correction for the presence of the aluminium made determinations of the total cross-section of this element necessary. Two resonance levels were found in the energy range 1·8–4·0 MeV.; one, at 2·4 MeV., has already been found by other workers[6,11]; the other, at 2·9 MeV., is new. Both levels have a width of about 0·2 MeV.

Further details of this work, which was carried out during the period November 1945–June 1946, will be published later.

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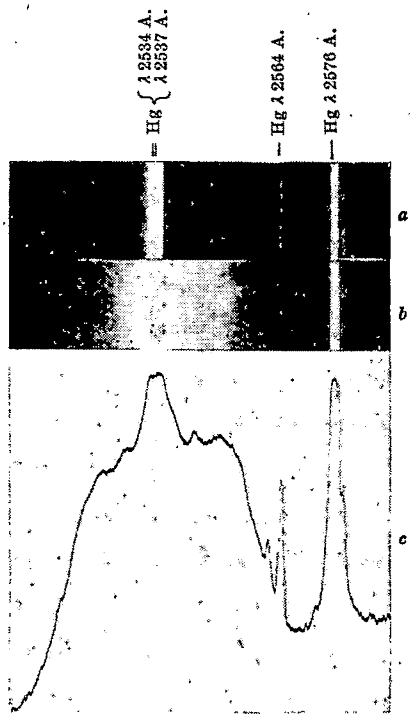
Born's Theory and the Spectrum of Light Scattering of Crystals

ACCORDING to Born's theory $3N$-6 vibrations of the crystal lattice must take place in a crystal (N is the number of atoms of the crystal). Consequently the spectrum of elastic vibrations of a crystal must be quasi-continuous. According to Born, this relates to the acoustic as well as to the optical branch of the spectrum of elastic vibrations of a crystal. The most complete analysis of the spectrum of elastic vibrations of a crystal, based on Born's theory, was carried out for rock-salt by Kellermann[1].

For some time past the basic conception of Born's theory has been criticized by Raman[2] and his collaborators. According to Raman, the optical branch of the spectrum of elastic vibrations of a crystal is not continuous but consists of a small number of discrete lattice vibrations of the crystal. The experimental investigations of the spectrum of second-order scattering of crystals are of great interest because they alone afford the possibility of obtaining the most complete picture of the whole spectrum of elastic vibrations, and thus of deciding which of the two theoretical conceptions referred to above is correct.



a, MERCURY SPECTRUM; *b*, SPECTRUM OF SECOND-ORDER SCATTERING BY A CRYSTAL OF POTASSIUM CHLORIDE; *c*, MICROPHOTOMETRIC RECORD OF *b*. *b* AND *c* SHOW A STRONG CONTINUOUS BACKGROUND

The most appropriate objects for such investigations are the crystals of alkali halides. Their simple structure simplifies the theoretical calculations of the spectrum of elastic vibrations and stipulates a simpler spectrum of scattering. The spectrum of second-order scattering for rock-salt, which consists of a group of broad maxima superimposed on a continuous background, was for the first time obtained by Fermi and Rasetti[3] and can be completely explained from Born's point of view[4].

Recently, Krishnan[5] investigated the scattering of rock-salt and some other crystals. He considers the results obtained to be in contradiction with Born's theory and in agreement with Raman's conception. In his experiments Krishnan did not observe the continuous background in the spectrum of second-order scattering of crystals, and its absence he regards as a most essential experimental fact which contradicts Born's theory. According to Krishnan, the spectrum of crystals consists of a number of discrete lines only, and Krishnan considers this to confirm Raman's conceptions.

The continuous background of the spectrum of the second-order scattering is a fundamental deduction from the theory of Born; therefore, the question of its existence or non-existence is of primary importance. For that reason we undertook new investigations of alkali halide crystals (potassium chloride, potassium bromide, and once more of rock-salt), our principal aim being to ascertain the existence of a continuous background in the second order Raman spectrum.

As other workers have done, we used as the exciting radiation the mercury resonance line λ = 2537 A. The crystals investigated were prepared from the corresponding fused salts. Our arrangement enabled us to obtain spectra of the second order in 5 hours with a slit-width of the spectrograph of 0·015 mm.

Our results show that the spectra of second-order scattering by crystals of potassium chloride, potassium bromide and sodium chloride are of the same type. The spectra are continuous, and on the background some discrete broad maxima of intensity are observed. The frequencies of the most distinct maxima for potassium chloride are 121 cm.$^{-1}$ and 201 cm.$^{-1}$, for potassium bromide 85 cm.$^{-1}$, 137 cm.$^{-1}$ and 204 cm.$^{-1}$. The distribution of intensities and the length of the spectra are different.

In the accompanying reproduction, the spectrum of a crystal of potassium chloride and its microphotogram are shown: an analogous microphotometrical curve was obtained for potassium bromide. The continuous spectrum of scattering of a crystal of potassium chloride is seen very distinctly.

We consider that the results of our investigations confirm Born's theory of the crystal lattice and contradict the conceptions of Raman.

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Oil-drop Method for Electron Trajectories

DEVELOPMENTS in electron optics during the past ten years have included automatic methods for plotting the electron trajectories through the fields of electrostatic electron lenses. These are exemplified by the ingenious devices of Gabor[1] and Langmuir[2], which also enabled the effect of selected portions of the field to be separately investigated. However, the apparatus required for such determinations is highly specialized, and not within the reach of the average laboratory. The alternative method of obtaining the potential distribution from electrolytic tank measurements, and enlisting the aid of the differential analyser to solve the trajectory equation, where this is possible, is again confined to institutions with the necessary equipment, and this may not be readily available.

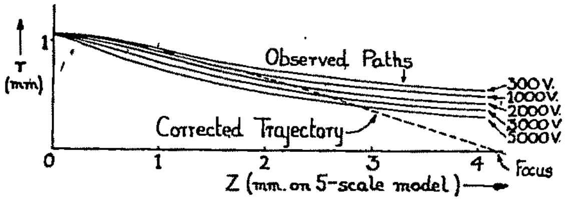
A method tried here seeks to overcome these inconveniences, by observing the trajectory of a charged oil drop in the actual field of the lens, in air at atmospheric pressure, and this is corrected by a simple calculation. (In high vacuum the trajectory of the oil drop would be that of an electron, since the path followed is independent of the e/m ratio of the particle.)

Use was made of the Millikan oil-drop technique or producing charged particles. The following liquids were tried: turpentine, water, colloidal gold, glycerine, nut oil, 'Apiezon' oil, colza oil. It was finally decided to use colza oil for the work in air (and 'Apiezon' oil for the later experiments in vacuum). The drops are blown into a chamber from a commercial atomizer using compressed air. They then fall under gravity into a glass cylinder which contains an enlarged model (× 5) of the electron lens, and thus into the field of the lens through three collinear small holes in the cathode, one central, the others 1 mm. on either side of it. A field established by giving suitable potentials to the electrodes acts upon the charged droplets, causing them to describe curved paths, in the field of the lens. The paths are made visible by scattering the light from a 1,000-watt projector lamp, which is concentrated by a series of lenses to give a beam of about 5 mm. diameter at the centre of the chamber. The actual trace can be followed and timed as the droplets cross the 'square' eyepiece of a low-power microscope, and a space-time curve plotted for both the axial and radial directions. The data obtained in this way in air are sufficient to enable a first approximation to the trajectory to be determined, and to give the form of the potential distribution along the axis, assuming that paraxial regions of the field are explored. Owing to the presence of the air, a term which allows for the viscosity effect has to be introduced into the equations of motion; these now take the form:

$$m\frac{d^2z}{dt^2} = q\frac{\partial V}{\partial z} + mg - 6\pi\mu a v_z,$$

$$m\frac{d^2r}{dt^2} = q\frac{\partial V}{\partial r} - 6\pi\mu a v_r,$$

where q is the charge, and a the radius of the drop. Both accelerations are small in air; the gradients can then be expressed in terms of the velocities.



The charge and weight of the droplet are determined as in Millikan's experiment from observations on the free fall under gravity, and under a uniform field. The time to traverse the field was roughly of the same order as in his experiments, and the use of Stokes' law appears justified under these conditions. Since the longitudinal and radial velocities, v_z and v_r respectively, could be observed, the field distribution is obtained by one graphical integration, and the radial displacement by two such integrations. The accompanying curves show the average of a large number of observed trajectories for an average value of mass and charge of 4×10^{-13} gm. and $(9\,e)$ respectively, at various anode voltages, together with the corrected trajectory for an anode voltage of 1,000 V. This gives values of focal length (or cross-over distance) of the immersion objective some 30 per cent higher than the theoretical, but capable of much improvement with more accurate measurements.

A first-order approximation can thus be obtained directly by this simple means. While most of the electron optical systems in use have rotational symmetry, this is not a strict requirement of the method, since the path is integrated automatically in the presence of the field, no matter what form this takes.

It is interesting to record the effects seen in the eyepiece as soon as the charged droplets enter the viewing space. These are four in number: (1) straight-line paths indicating the presence of neutral drops; (2) curved tracks due to the focusing field, and directed into the centre of the field; these correspond with the paths of negative particles; (3) curved tracks, away from the centre of the field, corresponding with positively charged particles; (4) straight-line tracks, in the early part of the field; these may begin to curve inward or outward owing to pick up by neutrals of a negative or positive charge.

As the sizes of drops ranged from less than 0·5 μ to 5 μ, that is, of the same order of magnitude as bacteria, the method opens up possibilities of 'focusing' charged bacteria and viruses by the use of electrostatic focusing lenses. The form of the field lines shows that in this case a maximum concentration of the charged bodies would be found at the 'cross-over' of the system. This is comparatively easy to locate. The use of plane fields, while not producing any focusing, would result in a sweeping out or filtering action, which might be beneficial from the public health point of view if suitably designed and placed in public places.

It is hoped to publish these results shortly and continue the work in vacuum at a later date.

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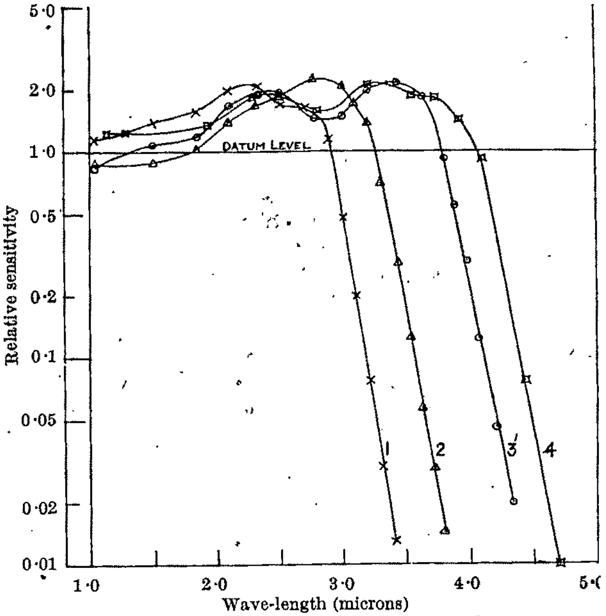
[2] *Nature*, **139**, 1067 (1937).

Spectral Sensitivity of Lead Sulphide Layers

Lead sulphide photo-conductive layers are now known as sensitive detectors in the near infra-red[1], but so far their usefulness has been limited to wave-lengths less than about 3 μ.

Measurements have been made on the spectral sensitivity of such photoconductive layers, and it has been found that there is a pronounced shift of sensitivity towards longer wave-lengths on cooling. The measurements were made with a Nernst source and a lithium fluoride (double prism) spectrometer in the region 1–5 μ, the spectral band-width varying from 0·08 to 0·03 μ over this range. The radiation from the Nernst filament was interrupted at 800 c./s. before entering the spectrometer, the signal from the layer being amplified in a receiver tuned to 800 c./s. with a band-width of 16 c./s.

The particular layer for which the results are quoted was made by chemical deposition, and had an area of 1 cm. × 1 cm., with a thickness of the order of 1 μ. As the accompanying figure shows, the wave-length at which the sensitivity has dropped to half its maximum value increases from 2·9 μ to 4·1 μ on cooling from room temperature to liquid hydrogen temperature. The curves are plotted as ratios of signal to root-mean-square noise in the absence of signal, and are relative to a datum level the value of which is quoted for each temperature. The glass of which the container for this layer was made has good transmission in the infra-red, with 90 per cent transmission up to 4·0 μ (except for a broad dip to 70 per cent at 3·0 μ) falling to 50 per cent at 4·5 μ. Practically all lead sulphide layers previously available were in 'Pyrex' glass containers the transmission of which is very poor beyond 3·5 μ, making it difficult to measure the true spectral response of the layer.



Signal/noise ratios for 16 c./s. band-width
Curve 1 : 290° K. datum S/N = 2·1 for 1 μ watt
" 2 : 195° K. " " 160 " "
" 3 : 90° K. " " 580 " "
" 4 : 20° K. " " 570 " "

The optimum sensitivity, achieved when cooling with liquid oxygen or hydrogen, is such that signal is equal to noise for an incident energy of 8×10^{-10} watts. This is approximately equal to the performance of the best available thermocouples, for the same equivalent noise band-width. However, the speed of response of the lead sulphide layer is some hundred times faster than that of a sensitive thermocouple; which is an important factor for many applications of such infra-red detectors.

The time constant of the lead sulphide layer was measured by irradiating it with a square pulse of light and measuring the rate of decay of the resultant signal on a cathode ray tube. The time measured is that required for the signal to decay to 1/*e* (37 per cent) of its initial value. The time of rise is only about two thirds of the decay time, and could not conveniently be measured in all cases.

Temperature	Decay time constant
290° K.	14 micro-sec.
195° K.	210 " "
90° K.	490 " "
20° K.	340 " "

The spectral shift is particularly important if the layer is to be used as a detector of radiation from a distant source, since in the near infra-red region the atmosphere is relatively non-absorbing only in the bands 2·0–2·3 μ and 3·3–4·0 μ.

For sources of moderate temperature (100°–300° C.) far more energy is radiated in the longer wave-length 'window', and thus cooling the layer greatly increases the signal received.

The above work was carried out at the Telecommunications Research Establishment (Ministry of Supply), and thanks are due to Dr. G. B. B. M. Sutherland for assistance in the liquid hydrogen measurements, and to the Admiralty Research Laboratory for supplying experimental layers.

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Electrical Conductivity of Molybdenite Crystals

Recently, the magnetic properties of molybdenite crystals have been studied in this laboratory at room temperature[1] and also at both high and low temperatures[2]. It was then thought desirable to extend the investigations on this crystal to electrical conductivity. The electrical conductivity of single crystals of molybdenite has been measured by various workers[3], but a more systematic study of the electrical properties was necessary in order to understand the nature of the carriers of the electric current in this crystal.

The electrical conductivities of some well-developed single crystals of molybdenite were measured at room temperatures and also at high and low temperatures (from 100° K. to about 500° K.). Conductivity along the basal plane ($\sigma_{\perp}$) is about 10^3 times greater than that at right angles to the basal plane ($\sigma_{\parallel}$). At room temperatures for currents both along and at right angles to the basal plane Ohm's law is not obeyed. But if the temperature of the crystal is raised to about 420° K., Ohm's law is perfectly obeyed for currents along both the directions (Fig. 1).

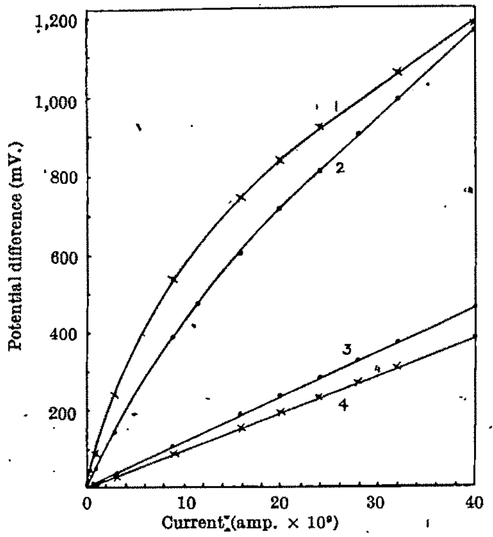

Fig. 1. Curve 1. Current-voltage curve for current at right angles to the basal plane at room temperature. Curve 2. Current-voltage curve for current along the basal plane at room temperature. Curve 3. Same at 420° K. Curve 4. Current-voltage curve for current at right angles to the basal plane at 420° K.

From the nature of variation of the conductivity with temperature, it has been found that at low temperatures the conductivities along both the directions have a tendency towards a temperature-independent value (Fig. 2). It is further apparent from the temperature variation of the conductivities that for both directions of the crystal there are two types of conductivities, one predominating at lower temperatures and the other at higher temperatures (Fig. 2).

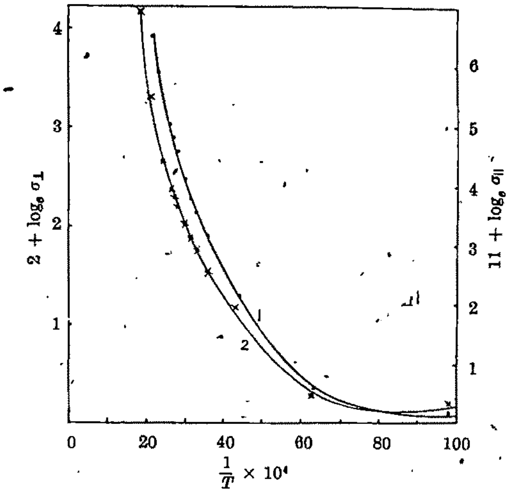

Fig. 2. Curve 1. Curve for current along the basal plane. Curve 2. Same for current at right angles to the basal plane

From these results it seems that the conductivity in molybdenite crystals at higher temperatures is effectively electronic.

Details of these investigations will shortly be published elsewhere.

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Disappearance of *Zostera marina*

This very common flowering plant used to cover large areas of estuaries of Britain, but about fifteen years ago it died out almost completely on both sides of the Atlantic, though not on the Pacific coasts of the United States. Evidence as to the present condition is now being sought, both here and in America. It would be much appreciated if those who knew the *Zostera* beds formerly would please send information as to continued absence or extent of regeneration, also as to whether anything else now occupies the areas thus left bare. The late Dr. E. J. Butler informed me in September 1938 that annually since 1932 he had watched a small 'meadow' in Guernsey. Though about 75–90 per cent went the first year, the rest was then holding its own. The fungus *Ophiobolus halimus*, Diehl and Mounce, was always present on it, but there was no sign of extermination. In fact, he thought there was some increase. There is very little of it around here now.

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Feb. 7.

Colours of Jupiter

In an interesting speculation, Wildt[1] suggested that the red and blue colours observed on Jupiter may be due to combinations of the alkali or alkaline earth metals with the ammonia which forms a large part of its atmosphere: the red to concentrated or 'metallic' solutions, the blue to dilute solutions. He left open the question of the source of the metals, but favoured the idea of meteoric dust, because of the spectroscopic detection of sodium in the night sky.

Although ingenious, the theory is improbable on several grounds. Even in the complete absence of oxygen and water it does not appear that the considerable quantities of metal required could be accumulated over the necessarily long period of time (the 'metallic' phase is $7N$ with regard to sodium at $-110°$), since it is known that light[2], and traces of transition metals, especially iron[3], which occur in meteoric dust, catalyse reaction with ammonia to give the colourless metal amides. Also, the red colours have been described as varying from 'brick-red' to 'rose-pink', while the 'metallic' phase of sodium in ammonia has a lustre of polished bronze, and solid calcium hexammine resembles brass; both are blue by transmitted light in thin layers. It is most unlikely, therefore, that they can give rise to true red colours either in solid, liquid or dispersed states.

The blue colour of metals in ammonia (visible at concentrations of less than $0{\cdot}00002N$ even with small volumes) is due to solvated electrons[4] and may be observed in solutions of ammonium (NH_4+, $e-$), so that a process for generating electrons (or ammonium radicals) may give rise to such a colour. On Jupiter possible sources of these may be found in photochemical reactions or atmospheric electrical charges.

ARTHUR J. BIRCH

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Feb. 5.

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The Desert Landscape

With arable land one of the most outstanding problems of the day, it is important to determine the criteria of the desert landscape so that reconstruction through the soil can be planned and commenced on a world scale[1]. Various definitions have been given of the nature of a desert, mostly based on weather (although the writers really mean climate), such as lack of rainfall or high rate of evaporation.

All such definitions become unwieldy and unworkable when applied in practice. For example, there is no lack of deserts which have high rainfalls, up to 60 in. per annum. Others have 20 in. and are still barren. It is difficult to formulate desert criteria unless the problem is approached from the soil point of view. If we define the desert landscape as one where the rate of soil erosion exceeds the rate of soil formation, and a genial area as one where the rate of soil formation is commensurate with erosion, then at once we have a dynamic conception which the soil conservationist can apply with vigour to his problems. This definition has the advantage that deserts are more likely to occur in areas where the equilibrium between rainfall and rate of evaporation is unstable, and hence deserts may form easily by soil erosion, without requiring changes of climate. This applies to South Africa, and many workers have shown the desert invasion that is now taking place without any change in climate that can be detected. Dr. Tidmarsh in the Karroo has prepared maps showing the increased desiccation of the soil that has taken place in the span of a few generations. With my colleagues I have drawn maps showing the present invasion, and others of the Pleistocene, Pliocene and Miocene are now being completed[2].

It is interesting to compare Pole-Evans' vegetation map with the rainfall distribution map of South Africa. There is general agreement, it is true, but very serious discrepancies in the central regions where desert vegetation is shown in rainfall areas of 20 in. per annum or more. When Pole-Evans' map is compared with that compiled by my colleagues and I, there is seen to be very close agreement indeed. In our map, as now brought up to date, the similarity is very close. When it is borne in mind that the maps were based on different criteria (in our map, on the sheet erosion that occurs in an area), then it is realized that this experimental approach has real merit.

V. L. BOSAZZA

P.O. Olifantsfontein,
Transvaal.
Jan. 26.

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Action of Mustard Gas (ββ′-Dichlorethylsulphide) on Thiol Groups of Proteins

In order to avoid any mistaken interpretation of the facts published in various papers[1], we wish to state clearly that the ββ′-dichlorethylsulphide we used in our investigations was a very pure colourless liquid of constant melting point prepared from constant-boiling thiodiglycol by the action of hydrochloric acid. It is known that impure mustard gas reacts more readily with —SH groups than the pure substance[2]. It appeared from the discussion at the recent Congrès de Chimie Biologique (Liège, October 1946), following the presentation of a paper by Prof. R. A. Peters, that our conclusions about the action of the various war toxic gases are generally in close agreement with those of the British and American authors (see ref. 3).

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M. GOFFART

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A VOLUMETRIC METHOD FOR A STUDY OF THE HISTORY OF EPEIROGENIC MOVEMENTS

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ANY territory which is sufficiently large may be divided for any geological age into areas of tectonic uplifts and subsidence of the earth's crust, the rate of uplift and subsidence being different for different places[1]. One may speak about an average and a 'volume' rate of subsidence and uplift, meaning the rate of increment of the total volume of all the tectonic depressions and convexities of the earth's crust within a given territory. This total volume rate of movements may be calculated. The volume of subsidences is approximately equal to the total volume of sediments accumulated during the given time. An elevation of the earth's crust causes erosion, and the volume of the uplift may be determined from the volume of the eroded clastic material[3,4]. In this way the problem is confined to a determination of the volumes, on one hand, of all the deposits accumulated; and on the other, to a separate determination of those of clastic deposits. Tracing from one geological age to another the change of these values, it is possible to study in volumes (cu.km.) the kinematics of the vertical movements of different signs. Referring these volumes to a unit of area (sq. km.) gives the average magnitude of subsidence or uplift of the earth's crust (in km.).

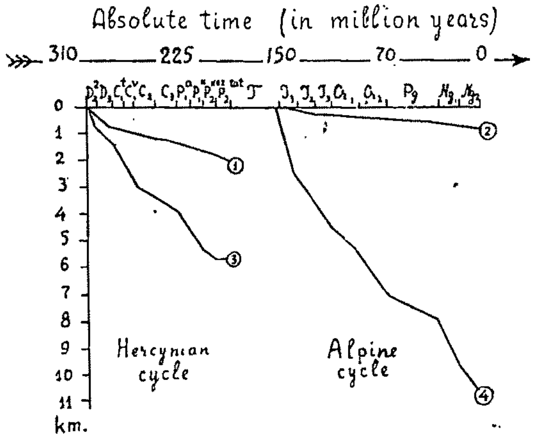

Fig. 1. CURVES SHOWING THE AVERAGE MAGNITUDE OF SUBSIDENCE OF THE HERCYNIAN (1) AND ALPINE (2) RUSSIAN PLATFORM, THE HERCYNIAN GEOSYNCLINE OF THE URALS (3), AND ALPINE GEOSYNCLINE OF THE GREAT CAUCASUS (4)

Fig. 1 shows the curves of the average magnitude of subsidence of the Russian Platform and the surrounding geosynclines during the Hercynian and the Alpine cycles. Here the difference in the scale of movements is of interest[3,4,7]. If the average magnitude of subsidence or uplift be referred to a unit of absolute time (a million years[2]), the average rate of vertical movements will be obtained[3,4]. Fig. 2 presents the curves of the average rate of subsidence of the Russian Platform, Uralian and Caucasian geosynclines; an examination of these will show that there is some parallelism and a similar periodicity in the movements of these different tectonic zones, the rate of subsidence on the Hercynian and particularly the Alpine platform having been considerably slower. Both the downward and the upward movements on the platform were somewhat retarded as compared to the movements of the adjacent geosynclines of the same age[4,7].

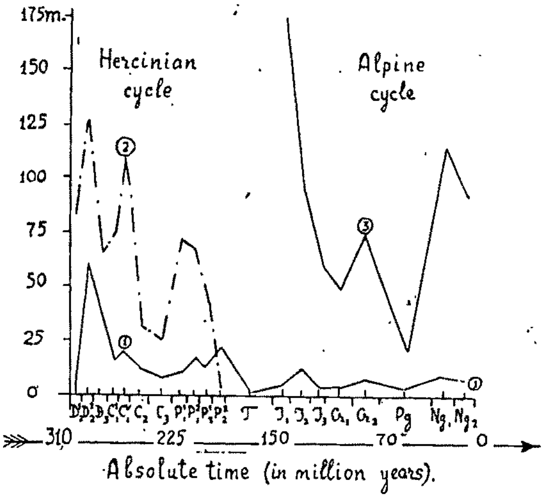

Fig. 2. CURVES SHOWING THE AVERAGE RATE OF SUBSIDENCE OF THE RUSSIAN PLATFORM (1) AND GEOSYNCLINES OF THE URALS (2) AND GREAT CAUCASUS (3), IN METRES PER MILLION YEARS

An estimation of the total volume of the rocks is made with the aid of isopachous maps. The volumes of terrigenous, carbonate, continental and volcanogenous rocks are measured by means of specially prepared isopachyte (equal thickness) maps separately for each of the rock types listed[4,6].

It is often impossible to measure the area from which the clastic rocks have been removed, since the region of the ancient erosion is overburden under younger deposits. In these cases we study the ratio of the volumes of terrigenous rocks (V_1), removed from the region of uplift, to the total volume of rocks (including effusives) (V_2), accumulated in the surrounding regions of subsidence during the same time interval.

This ratio, named the 'uplift coefficient' (δ), in the first approximation is equal to the relation between the volume of uplifts to the volume of subsidences of the earth's crust:

$$\delta = \frac{V_1}{V_2} = \frac{\text{uplift}}{\text{subsidence}}. \qquad (1)$$

Studying in this way one division after the other, we find the changes of δ in the course of time. In many cases this is sufficient to make it possible to draw important conclusions regarding the development of epeirogenic movements[4].

Since we refer the volume of terrigenous rocks to the total volume of all rocks, the ratio can never exceed unity. Hence it is not possible in this way to determine the cases when the volume of uplifts exceeds that of subsidences. However, such cases do exist, and it is necessary to have some means of determining them. With this object in view, a correction to a change of facies is introduced. If the total of uplifts exceeds that of subsidences, the amount of material removed is greater than the corresponding space in the areas of subsidence, and the surface of sediments in the zones of accumulation is raised. The additional volume of rocks obtained as a result of rise of the level of sediments (v) is subtracted from the total volume of rocks. The correction (v) but with the opposite sign is used when a lowering of the surface of sediments (a deepening of the basin) has occurred during this time interval:

$$\delta = \frac{V_1}{V_2 \pm v} = \frac{\text{uplift}}{\text{subsidence}}. \qquad (2)$$

Fig. 3 shows the changes of the uplift coefficient (δ) in the Uralian geosyncline from the Cambrian to the Permian. We see that the curve records two large cycles of epeirogenic movements (Caledonian and Hercynian), upon which second order cycles are superimposed. The beginning of each large and small cycle is characterized by a predominance of uplifts; at the middle, subsidences become prevalent; and at the close of a cycle, the significance of uplifts of the earth's crust again increases. An analogous curve has been obtained for the Caucasian geosyncline[4].

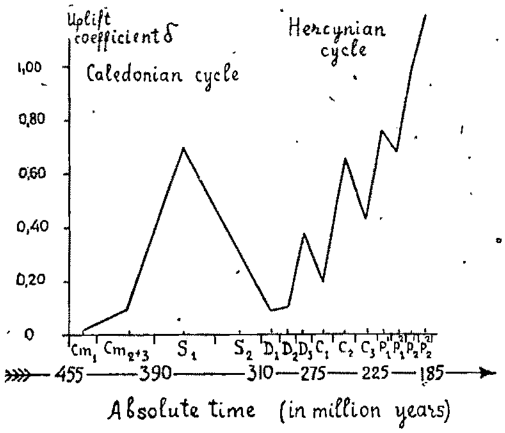

Fig. 3. CURVE SHOWING THE RATIO OF UPLIFTS TO SUBSIDENCES IN THE URAL GEOSYNCLINE

An important part in quantitative estimations is played by the determination of the boundaries of the territory actually studied. Since the volumes of clastic rocks are taken into consideration, all the areas which have supplied terrigenous material in this particular case are automatically included in the territory studied.

I have also used the volumetric method for a quantitative study of the Hercynian volcanism in the Urals[5] and of the history of sedimentation within the European part of the U.S.S.R.[6]. As a result, a number of regularities have been established which so far have escaped detection by the usual methods of geological investigation.

PSYCHOLOGISTS IN THE ASSOCIATION OF SCIENTIFIC WORKERS

THE Section of Psychology, lately formed inside the Association of Scientific Workers, met for the first time at Bedford College, London, on January 18; in the chair was Mrs. Winifred Raphael, of the National Institute of Industrial Psychology. The speakers were Miss I. M. Dunsdon, Dr. H. J. Eysenck, Miss Pearl King, Prof. T. H. Pear, Mrs. Raphael, Dr. J. D. Sutherland and Dr. Stephen Taylor, M.P. All the papers were followed by discussion. Until this meeting, psychologists had met within the Association of Scientific Workers as part of its Medical Section. The establishment of a Psychological Section has resulted in a considerable increase in the number of psychologists joining the Association (117 up to the time of writing).

The chief subjects emphasized were the relations between psychologists and other professional workers, and the ways in which psychologists may make practical contacts with others and contribute usefully from their sphere of knowledge. There is an obvious division between fields in which psychologists can make an immediate contribution, and those in which they might help after research into specific problems has been conducted. It was felt that a subject of international importance is "channels of communication", for example, the Press, radio, films, etc. An investigation into this subject is in progress.

It was urged that the Association of Scientific Workers might consider putting forward a more definite policy with regard to the results of recent scientific research, such as the atomic bomb and other revolutionary weapons of war. Certain psychologists specially interested in the subject could help by advising upon ways of 'getting ideas across' to the public.

The primary responsibility of psychologists as such is to work whole-heartedly for the advancement of their science. To-day in most sciences comparatively little can be done by individual workers, and the importance of co-ordinated research here as elsewhere was stressed. The time may even have come for university departments of psychology to establish a co-ordinating body so that (1) research workers can know what others are doing at present in their field and thus avoid duplication, and (2) plans for research into fundamental problems can be developed.

An urgent need is to let the public—at present badly instructed—know what psychology can and cannot do. More use could be made of the ordinary media of communication by psychologists who can express complicated ideas simply and clearly; but this might require a changed attitude upon the part of some editors.

Dr. Stephen Taylor discussed the possibilities and conditions of employment of social psychologists in the public services.

Dr. J. D. Sutherland considered "Relations between Psychologists and Other Professional Workers". Such relations, where they exist, are on the whole good. Probably the oldest and closest is in the educational field, because of its more obvious psychological implications. He deplored the fact that as yet there seems to be almost no co-operation between psychology departments and university authorities in the problems of selecting and training university students.

In the industrial field, relations are good, partly because only progressive industrialists ask for

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[2] Holmes, A., "The Age of the Earth" (1937).

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[5] Ronov, A. B., *Bull. Acad. Sci. U.R.S.S.*, sér. géogr. et géophys., 10, No. 4 (1946), in Russian, with English summary.

[6] Ronov, A. B., *C.R. (Doklady) Acad. Sci. U.R.S.S.*, **50** (1945), in English.

[7] Ronov, A. B., *C.R. (Doklady) Acad. Sci. U.R.S.S.*, **50**, No. 2 (1946), in English.

psychological advice. Psychological work in the Forces has improved relations with Government services. Co-operation with trade unions is unsatisfactory, but it is hoped that the Association of Scientific Workers will now improve matters. In medicine, relations are becoming increasingly better. Co-operation with social scientists, however, is not what it might be.

Dr. Sutherland suggested that methods of recruitment of psychologists and their training for 'real life' could be improved, also that university psychology departments might assume more practical responsibilities concerning students' careers. There is a need for good popular literature on psychology. Very few intelligent members of the lay public, he said, know any names of psychologists other than Freud, Jung and Adler.

Miss Dunsdon, reporting on "A Survey of the Fields of Employment of Psychologists", described a questionnaire to be circulated to all psychologists in the British Psychological Society. The object of this survey is to obtain information concerning psychologists' working conditions, their hours, salaries, holidays, facilities for research, etc.

Dr. Eysenck presented a report on the facilities for training psychologists, based on a circular sent out by the British Psychological Society in 1944. It indicated that the following developments are needed: (1) more psychology departments in universities, (2) adequate equipment, laboratory and library facilities, journals, copies of tests, etc., (3) better staffing, (4) more stress on social psychology, (5) developments making it easier to specialize, in particular by giving practical, clinical and other facilities, (6) revision of some qualifications for admission to universities.

T. H. Pear

CROSBY HALL, LONDON

In the summer of 1946, after several years of war service as a training centre for the Women's Royal Naval Service, Crosby Hall was re-opened by the British Federation of University Women as an international hall of residence and club-house for university women. Fortunately, the beautiful fifteenth-century Hall was comparatively little damaged by bombs; and although the residential quarters were considerably injured by blast it was possible to restore them without actual re-building.

The Hall, as in pre-war days, has again become a centre for international culture and friendship, where university women from all over the world can live and study, meet and exchange views, go for short visits or use the club facilities provided. In these few months women of thirty-two different countries, from China to Paraguay and from Iceland to South Africa, have stayed here. British women are able to use the Hall for permanent residence or visits in just the same way, and although there is no fixed rule as to proportions between overseas and British residents, there usually seems to be a happy balance. Research and post-graduate students have first claim to residence. Second 'priority' is given to members staying for short visits on business or pleasure. The first Council meeting of the International Federation of University Women to take place since the War was held at Crosby Hall last summer, and no more appropriate event could have marked the re-opening. The third group of 'priorities' is that of graduates employed in London.

The Great Hall, with its magnificently carved oaken roof, its stonework tracery and tall oriel window, dates from 1466, and is of much historic interest. Originally a part of the city mansion of Sir John Crosby, it was taken down stone by stone and re-erected on Chelsea Embankment. In 1927 the British Federation of University Women, which had succeeded in raising £50,000 for the purpose of acquiring the Hall and building a residential wing, opened Crosby Hall as an international residence and club-house. It is especially fitting that the building should be on the site of the Chelsea home of Sir Thomas More, the great scholar whose circle of friends included men of learning from all over Europe, and who scandalized his contemporaries by insisting that his daughters should have the same education as his son.

Even before the War it was clear that the accommodation at Crosby Hall was not sufficient to meet the demand. The first residential wing had only been a part of the original building plan, and early in 1946 an appeal was launched to complete the scheme by building a second wing, a library and additional common-rooms. At the same time a Fellowship Fund was started in order that many university women who would most benefit by residence at Crosby Hall should not be debarred through lack of means. A special appeal to schools was made at the beginning of the year. An Association has just been started, under the title of "Friends of Crosby Hall", to link together those who are interested in Crosby Hall and concerned to see that this beautiful building is cared for, used and loved. The small subscription, which goes towards the maintenance and extension of the building, also entitles the member to lunch in Hall and to invite guests. Quite apart from this Association, the Warden of Crosby Hall will always be glad to show school and college parties—or individuals—over the Hall by arrangement.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 14

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. H. H. Nicholson: "The Problem of Land Drainage".

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. G. Milton: "Research and New Developments in Water Treatment".

Society of Chemical Industry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. R. P. Linstead: "Chemistry and Autarchy".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Mr. J. C. E. Strong and Mr. C. A. Wright: "The Measurement of Surface Finishing"; Mr. J. A. Yates: "Automatic Control of Specific Gravity".

Tuesday, April 15

Royal Society of Arts, Dominions and Colonies Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. T. S. Simey: "Social Welfare in the West Indies".

Society of Chemical Industry, Agriculture Group (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. N. Pizer: "The Advisory Chemist and Problems in Crop Production".*

British Society for International Bibliography (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—Dr. B. M. Crowther: "The Use of the Universal Decimal Classification in Periodical Abstracting Services for Scientists and Engineers".

Institution of Mining and Metallurgy (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Major-General A. J. Orenstein: "The History and Prevention of Silicosis, with special reference to the Witwatersrand" (First Sir Julius Wernher Memorial Lecture).*

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Linford Rees: "The Physical Constitution in Mental Illness".*

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Does Standardization Conflict with Progress?" (to be opened by Mr. J. W. Dalgleish).

Illuminating Engineering Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Papers dealing with Problems associated with Searchlights (Visibility, Photometry, Design. etc.), followed by a Discussion.

Institution of Structural Engineers, Lancashire and Cheshire Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Mr. F. L. King: "Stress Recording in Bridges and Stresses due to Impact".

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—Mr. John L. Rait and Mr. H. W. Pinder: "Origin and Constitution of certain Non-metallic Inclusions in Steel".

Wednesday, April 16

Royal College of Surgeons of England (at Lincoln's Inn Fields, London, W.C.2), at 3.30 p.m.—Dr. James Craigie, F.R.S.: "Relationships of Virus and Host-Cell, with reference to Latent and Cryptic Infections" (Imperial Cancer Research Fund Lecture).

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Brigadier R. A. Bagnold, F.R.S.: "Experimental Work on the Movement of Coastal Sands and Shingles".

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5 p.m.—Prof. A. Bradford Hill: "Medical Statistics".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Rt. Hon. Oliver Lyttelton, M.P.: "Economic Reconstruction, 6. Production".

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. Burke, Mr. R. C. Cuffe and Mr. W. O'Neill: "Record of Experience on the Irish Electricity Supply System".

Institution of Production Engineers, Sheffield Section (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p.m.—Mr. C. P. Tupholme: "Stainless Steels".

Society of Chemical Industry, Food Group (joint meeting with the London and S.E. Counties Section of the Royal Institute of Chemistry, at the Wellcome Research Institution, 183 Euston Road, London, N.W.1), at 6.30 p.m.—Dr. D. W. Kent-Jones: "Modern Trends in Cereal Chemistry in America and Elsewhere".

Society of Dyers and Colourists, Northern Ireland Section (at Queen's Hotel, Belfast), at 7.30 p.m.—Annual General Meeting.

Thursday, April 17

Royal Society of Arts, India and Burma Section (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Hugh G. Rawlinson: "The Influence of India upon European Culture".

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. R. Baker: "Is the Cell-theory True?"; Dr. P. H. Gregory: "The Biology of the Air".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. P. A. Hufton: "Testing Civil Aircraft".

Society of Chemical Industry, Road and Building Materials Group (at 1 Grosvenor Place, London, S.W.1), at 6 p.m.—Mr. W. P. Andrews: "Modern Road Construction in Concrete".

Chemical Society and the Royal Institute of Chemistry (joint meeting of the Manchester Sections, at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. A. H. Baines: "Recent Work in Colour Photography".

Royal Photographic Society, Scientific and Technical Group (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. G. W. W. Stevens: "Some Optical Complications of Graticule Production".

Pharmaceutical Society, Manchester, Salford and District Branch (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Annual General Meeting.

Chemical Society (at Burlington House, Piccadilly, London. W.1).—Discussion on "Electrolytic Solutions".

Wednesday, April 16—Thursday, April 17

Institution of Mining Engineers (joint meeting with the Institution of Mining and Metallurgy, at the Royal Institution, 21 Albemarle Street, London, W.1).—Conference on "Silicosis, Pneumokoniosis, and Dust Suppression in Mines" (to be opened by the Rt. Hon. Emanuel Shinwell, M.P.).

Wednesday, April 16

At 10.30 a.m.—First Session; at 2.30 p.m.—Second Session.

Thursday, April 17

At 10.30 a.m.—Third Session; at 2.30 p.m.—Fourth Session.

Friday, April 18

North-East Coast Institution of Engineers and Shipbuilders (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. Arnold Emerson and Mr. L. W. Berry: "Experiments in the Lithgow Propeller Tunnel".

Society of Chemical Industry, Birmingham Section (joint meeting with the Plastics Group, at the Chamber of Commerce, Birmingham), at 6.30 p.m.—Prof. H. Staudinger: "Vinylidene Chloride and its Polymers".

Society of Dyers and Colourists, Manchester Section (in the Lecture Theatre, Gas Department Showrooms, Manchester), at 6.30 p.m.—Dr. G. L. Royer: "Rayon Dyeing".

Institute of Physics, Manchester and District Branch (in the New Physics Theatre, The University, Manchester), at 6.30 p.m.—Annual General Meeting; at 7 p.m.—Mr. D. O. Sproule: "Material Testing by Supersonics".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturers in Science (3, men or women) in the Training Department, with emphasis respectively on Botany, Physics and Chemistry—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (April 15).

Lecturer in Industrial Administration—The Registrar, College of Technology, Manchester 1 (April 15).

Senior Lecturer in Mechanical Engineering—The Registrar, College of Technology, Manchester 1 (April 15).

Chief Examiner (Chemist, male), and a Senior Examiner (Chemist, male), in the Ministry of Supply—The Ministry of Supply (Est. 5 C), Leatherhead, Surrey (April 16).

Deputy Public Analyst, and a Senior Assistant Analyst (male)—The Clerk of the County Council, County Buildings, Stafford (April 17).

Principal—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (April 18).

Officers (2) to take charge of the maintenance of experimental animals—The Director, Genetics Laboratory, Institute of Animal Genetics, West Mains Road, Edinburgh 9 (April 19).

Assistant Experimental Officers (2) to assist in experimental work on breeding and selection of small animals (insects)—The Director, Genetics Laboratory, Institute of Animal Genetics, West Mains Road, Edinburgh 9 (April 19).

Head of the Engineering Department—The Principal, County Technical College, Dartford, Kent (April 19).

Educational Psychologist—The Director of Education, Education Offices, Leeds 1 (April 21).

Professor of Child Health—The Secretary and Registrar, The University, Bristol (April 21).

Lecturer in Biology and Horticulture at the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (April 21).

Lecturer in Physics—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (April 21).

Assistant Lecturer in Geography—The Registrar, The University, Manchester 13 (April 24).

Lecturer in Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (April 25).

Entomologist to carry out a survey of the tsetse areas of the Southern Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Veterinary Entomologist' (April 28).

Assistant Masters (qualified, graduate) for Science (to Higher School Certificate), and Geography (to Higher School Certificate), at the Duke of York's Royal Military School, Dover—The Under-Secretary of State, War Office (A.E.1), 45 Eaton Square, London, S.W.1 (April 28).

Professional Officers in the Tobacco Branch of the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (April 30).

Lecturer in Surveying in the Mining Department—The Registrar, The University, Leeds 2 (April 30).

Lecturer in Geology at the Natal University College, Durban—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (April 30).

Junior Professional Officer (woman) in the Branch of Botany and Plant Pathology, Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (April 30).

Readership in Chemical Engineering tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

Professor of Preventive Medicine—The Registrar, The University, Manchester 13 (April 30).

Lecturer in the Economics of Colonial Agriculture—The Registrar, University of Oxford, Oxford (April 30).

Assistant Lecturer or Lecturer (*a*) in Applied Mathematics and (*b*) in Statistics—The Registrar, The University, Leeds 2 (April 30).

Assistant Lecturer in Botany—The Registrar, The University, Leeds (April 30).

Research Officer (Ceramics Research) at the School of Mines, Adelaide—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1212 (May 3).

Officer-in-Charge, Instruments Section, Division of Aeronautics, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1213 (May 3).

Research Officer, Division of Entomology, Canberra—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1218 (May 3).

Readership in Civil Engineering tenable at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 6).

Lecturer in Metallurgy—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Assistant to the Advisory Bacteriologist—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8.

Assistant Fuel Technologist for the Plant Engineering Division—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Plant Engineering Division'.

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NATURE

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UNIVERSITY DEVELOPMENT IN GREAT BRITAIN

THE need for more effective organisation in the universities of Great Britain for the interchange of views at all levels and in all the fields concerned has been recognized in the Barlow Report and also in reports from the Parliamentary and Scientific Committee, Association of University Teachers and other bodies. The last report from the Parliamentary and Scientific Committee suggested that the annual conference of representatives of the different universities and of the Association of University Teachers might well provide the basis for some such more permanent and active means. If this conference set up standing committees and invited specialist advice from outside the universities, it might become the active and influential consultative body which has long been needed in university affairs, and to provide which a Universities Council had previously been recommended by the Parliamentary and Scientific Committee as well as by the Association of University Teachers.

Such a joint meeting did, in fact, take place in September 1946 at the invitation of the Committee of Vice-Chancellors and Principals, and it is understood, according to Sir Ernest Simon, that a similar representative universities council will meet this year. This is a step in the right direction, and it is important because, although the Government has already announced new and extended terms of reference for the University Grants Committee, the ambitious programme of university expansion visualized in the Barlow Report on Scientific Man-power and in the report of the Parliamentary and Scientific Committee can only succeed if there is collaboration in shaping policy all the way through the university world. Moreover, if such expansion is to take place without loss of independence on the part of the universities, and the University Grants Committee is to exercise more positive functions, the universities must evolve a satisfactory organisation of their own.

For this reason "A Note of University Policy and Finance in the Decennium 1947–56", which was prepared in July 1946 by the Committee of Vice-Chancellors and Principals, in order to present to the University Grants Committee the collective views of the vice-chancellors of British universities on certain important issues, both of policy and finance, which seemed to arise from the succession of official reports dealing with various aspects of university activity, is a document of outstanding interest and importance. According to a statement by Sir Hector Hetherington, chairman of this Committee, published in the *Universities Quarterly* of February, the note is not a private document, and copies have been furnished to each university for distribution and use as might be thought fit. The first part of the note deals with questions of administration. Part 2 deals with finance, and concludes that the proportion of university income to be found from Government services will be increased from roughly one third to three quarters in the next few years. Part 3 discusses the future relations of the Government and the universities in Great Britain.

In this part of the note it is stated that the universities entirely accept the view that the Government has not only the right, but also the duty, of satisfying itself that every field of study which in the national interest ought to be cultivated in Great Britain is in fact adequately provided for in the university system, and that the resources which are placed at the disposal of the universities are being used with full regard both to efficiency and to economy. In the view of the vice-chancellors, therefore, the universities may properly be expected not only individually to make proper use of the resources entrusted to them, but also collectively to devise and execute policies calculated to serve the national interest. In that task, both individually and collectively, the universities would be glad to have a greater measure of guidance from the Government than until quite recent days they have been accustomed to receive.

Pointing out that from its foundation the University Grants Committee has exercised a positive influence on the policy of every university, the note states that in the last twenty years probably no university has undertaken any important development without full consultation with the Committee and its officers. The universities have always recognized that inevitably and rightly the Committee has the duty, in its financial decisions, of basing its judgment on the merits of their policies. Hence the vice-chancellors would be glad if the University Grants Committee were formally authorized and equipped to undertake surveys, in all the main fields of university activity, designed to secure that as a whole the universities are meeting the whole range of national need for higher teaching and research.

The vice-chancellors emphasize their belief that it is common ground that the universities should continue to be in the fullest sense of the word self-governing societies, accountable for what they do or fail to do, properly subject to criticism, and affected in their fortunes by the public judgment of their policies; but in the last resort, their own masters. The fundamental duty of the university teacher, in his own field of study and inquiry, to pursue and to communicate with the utmost objectivity such measure of truth as he can attain, and the importance in a free society of safeguarding that fundamental truth from any risk of abridgment, are well stressed. While, however, the University Grants Committee will need to call upon the services of many experts in different fields and to add to its secretariat and even to the number of its whole-time stipendiary members, the vice-chancellors do not wish to see any fundamental change in the size or character of the Committee. The Committee is probably already near the limit of numbers for an effective working body, and the vice-chancellors believe that it will best serve its purpose if it continues to be composed as at present largely of members of distinguished academic experience selected for their personal fitness, and not in a representative capacity, giving part-time service for a period of years. An acceleration of techniques already in some degree in operation is regarded as the primary need.

An addendum from Sir Richard Livingstone, who was not present at the discussion on this part of the note, records his own view that the University Grants Committee should survey the university system of Great Britain in order to secure that the universities of the country cover the necessary fields of study, so that the Committee might give such advice to the universities as it believes necessary. With this help, Sir Richard thinks that the universities can and should be trusted to take such measures as the interest of the country and the needs of learning and education dictate.

From one point of view, this part of the vice-chancellors' note, although the shortest, is the most important; but there are certain points in the preceding sections which deserve to be noted also. Starting from the report of the Barlow Committee, the vice-chancellors comment on the divergence between claims upon university man-power presented by the Hankey and by the Barlow Committees. While the universities are both willing and ready to meet, to the best of their ability and from the resources made available to them, both new and increased demands, provided the demands are in the national interest and are not incompatible with activities appropriate to the university field, they are not in a position to judge finally as to the order in which priorities would best accord with the nation's needs; nor can they estimate, on a long-term plan, how far demands upon them put forward as immediately necessary are likely to remain permanent. On the need for doubling the pre-war number of graduates in science, the vice-chancellors hold that in no single university should a great increase in one major faculty be unaccompanied by corresponding increases in the other major faculties. Again, in insisting upon the need for such balance in expansion, the vice-chancellors also observe that the improvement of the universities requires a first place in the programme of educational expansion; and they are reserved on the question as to whether there is a sufficient proportion of innate ability in the population to provide double the pre-war number of students able to profit by a university education. The provision for expansion, in their view, would best be made by expanding existing institutions properly rather than by founding a new university, at least in the first decade.

The second and longest part of the vice-chancellors' note is that dealing with finance. This covers both capital outlay and recurrent expenditure, as well as discussing the necessary priorities in man-power and materials. The capital aggregate of the needs reported by each university to the University Grants Committee in March 1944 was £28 million on a 1938–39 basis of costs, a figure for which the vice-chancellors now provisionally substitute £45 million, or, translated into 1947 probable building costs, something of the order of £80 million, to be spent by the end of the decade 1947–56. For this purpose the vice-chancellors advocate the creation of a Treasury fund, secured by the Government in advance to the

University Grants Committee, so that the universities shall know definitely what capital outlay they each can make during the first five years of the decade, and approximately what further capital outlay they can make collectively during the second five years. The apportionment of this latter sum among the universities should be made by the University Grants Committee before the second quinquennium arrives.

This method of capital finance is urged by the vice-chancellors independently of the level at which expansion takes place, and they also press as essential for continuous development adequate priorities in building material, man-power for building and licences, *pari passu* with the national housing programme in 1947. Private benefactions can only form a small percentage of the total capital now required by the universities for sites, buildings and permanent equipment. As regards recurrent expenditure, the vice-chancellors consider not only the call for expansion but also the incidental factors such as the increased cost of equipment and materials for teaching and research, both books and apparatus, the need for upward revision of salaries, the increased expense of halls of residences, and, as already indicated, they reach the conclusion that if the universities are to meet the national needs of the decade, their pre-war combined annual revenue must be trebled; and of this total revenue, three quarters will have to be found from Government sources by way of the University Grants Committee.

In a written reply in the House of Commons on March 10, the Chancellor of the Exchequer stated that he proposes to resume the pre-war practice of settling Exchequer grants to the universities for periods of five years, and that Parliament will be asked to provide recurrent grants rising from £9,000,000 for the academic year 1947–48 to £9,970,000 for 1948–49, and then by annual increments to £11,920,000 for 1951–52. These figures exclude the grant of £500,000 now made to teaching hospitals, the amount of which for future years has not yet been determined, and they also exclude grants for agricultural education, responsibility for which will pass to the University Grants Committee after the current year. The Chancellor has also accepted the estimate of that Committee for non-recurrent grants during the quinquennium of £40 million for new buildings and £10 million for sites, existing buildings and new equipment. The Chancellor stated that he will do his best to meet the stimate; even allowing for a high degree of priority, however, the Minister of Works considers that universities will be unable to undertake more than 20 million of new buildings during the quinquennium.

This reply shows that the Chancellor is prepared to go a fair way to meet the views expressed by the vice-chancellors in their note, and further evidence of his general attitude is provided in a letter to Sir W. W. Wakefield, deputy chairman of the Parliamentary and Scientific Committee, concerning its eport on "Universities and the Increase of Scientific Man-Power". Mr. Dalton believes that that report under-estimates the number of scientific workers who will be available in 1955 and 1965, and over-estimates the number of retirements in the second decade. The Chancellor estimates that there will be 104,000 scientific workers by 1965, after allowing for the loss of 18,000 from retirement and 5,000 from choice. Again, he doubts the practicability of effecting university expansion to the extent suggested in that report or in that of the Barlow Committee, and accepts rather the estimate, based on investigations made by the University Grants Committee, of 88,000 as the maximum number of science graduates in the next ten years if academic standards are not to be lowered.

The Chancellor also indicated that he shared the views of the Parliamentary and Scientific Committee and also of the vice-chancellors on the inadvisability of founding a new university at this stage. He is in sympathy with the upgrading of some university colleges to university standard, and is clearly open-minded on the question of developing several universities out of constituent colleges of the University of London. He is dubious as to the wisdom of bringing certain technical colleges to university standard, and does not agree with the Parliamentary and Scientific Committee that existing salary scales will be a deterrent to the recruitment of university teachers.

While this letter makes evident the anomaly in the higher educational system of Great Britain, which places the development of universities and colleges of technology under different ministers, the Chancellor's observations are distinctly encouraging and promise all that could be expected at the moment. Furthermore, the vice-chancellors' note shows that there is full support within the universities for the action the Government has already taken in extending the functions of the University Grants Committee. This frank recognition of the necessity of some over-all attempt to plan the resources and expansion of the universities in accordance with national needs, broadly understood, is accompanied by the statement that the vice-chancellors would not exempt the universities themselves from the necessity of playing their own part in the co-operative planning of the whole university system. It falls to them, at least as much as to the University Grants Committee, to devise methods of working together to ensure the fulfilment of their common task. Some matters call for central discussion on the national scale, while others are best dealt with regionally. There are also the important and complex relations with the Dominion universities, with the higher educational service of the Colonies and with the universities of the United States and of Europe.

The vice-chancellors have recently appointed two committees, drawn from experts in particular problems outside the membership of the Committee, to report on matters of general consequence to the universities. Other similar studies will be undertaken as speedily as conditions allow. In this way and in others, the vice-chancellors hope that the universities of Britain will be able to co-operate with one another and with the University Grants Committee in the planning and development of a full range of university service.

It seems clear, therefore, from this note that the universities are prepared to participate in planning their future expansion and development, and that they are also unanimous that the Committee of Vice-Chancellors and Principals should play the part of a national negotiating body in which they have full confidence. The Committee is also understood to be inquiring at the present time into the whole question of halls of residence for the modern universities; and it should also be noted that the universities have already been asked to quadruple their grants to the Universities Bureau of the British Empire, a body which finances the Committee of Vice-Chancellors and Principals and provides its secretariat.

Clearly the Committee cannot work without a strong secretariat, as was pointed out by Sir Ernest Simon in his pamphlet "The Development of British Universities" three years ago, and as has since been emphasized by the Parliamentary and Scientific Committee in its latest report.

Some of the proposals for expansion of the individual universities and suggestions for the establishment of new universities, at least as currently reported in the Press, appear to show little appreciation of the importance of planning the national resources for university development to the best general advantage. That manifestly is the desire and intention of the vice-chancellors and of the Chancellor of the Exchequer; and while both have shown the desire to plan resources in this way, the statements issued assure to the universities the sole responsibility of determining trends of research and the training of scientific workers, and there is to be no interference with research funds. These statements indicate that university development in Great Britain is likely to proceed on sound lines, with sufficient Government support and without undue outside interference.

LAST TESTAMENT OF A PHYSICIST

Fundamental Theory

By Sir A. S. Eddington. Pp. viii + 292. (Cambridge: At the University Press, 1946.) 25*s*. net.

SIR ARTHUR EDDINGTON died in 1944. He left, almost completed, a manuscript entitled "Fundamental Theory". Sir Edmund Whittaker was invited by Miss Eddington and the syndics of the Cambridge University Press to supervise the publication of this manuscript in book form, and the volume under review is the result. Sir Edmund Whittaker has added to what must have been no light task by contributing to the *Mathematical Gazette* (29, 137–44, Oct. 1945) a clear introductory account of the material in the volume. Prof. E. T. Copson, of Dundee, and Prof. G. Temple, of King's College, London, have assisted Whittaker in the proof-reading. The gratitude of all who knew Eddington, either personally or through his writings, is due to the mathematicians mentioned for preserving for posterity a remarkable document, the last scientific testament of one of the profoundest thinkers of our time.

The scope of the book is not properly indicated by its title, since it does not deal with the foundations of physical science in the ordinary sense. It should have been called, perhaps, "Advanced Theory", for it assumes not merely a knowledge of, but also the actual conclusions of, the general theory of relativity and the quantum theory. Its aim is to weld the two into a single discipline, and in the course of the attempt it claims to complete what for years had been a main theme of Eddington's doctrines, namely, the calculation of the molar, microscopic and nuclear constants of Nature in terms of pure numbers, by analysis of the group-structure of the physical universe. The first five chapters reproduce almost verbatim the text of his Dublin Lectures of 1943, "The Combination of Relativity Theory and Quantum Theory" (*Dublin Inst. Adv. Studies*, Series A, No. 2), and are devoted to the uncertainty of the reference frame and what Eddington calls *multiplicity factors*; the next three reproduce in terser form the substance of his "Relativity Theory of Protons and Electrons" (Cambridge, 1936), and are devoted to an exposition of his very beautiful sixteen-dimensional non-commutative calculus, by which he claims to represent all the characteristics, mechanical, electrical and magnetic, of *particles* considered as *carriers of variates*; the remaining four chapters apply the sedenion analysis thus developed to such physical problems as the levels of the hydrogen atom, the masses of the proton, neutron, deuteron and helium nucleus, the separation constant of isobars and the mass of the mesotron, and to such more general questions as the wave equation, the electromagnetic field and radiation. As an appendix there is reprinted Eddington's paper in the Cambridge Philosophical Society's *Proceedings* (40; 1944) on the evaluation of the cosmical number N.

The volume is brilliantly written; but the physical argumentation is so unfamiliar, so involved, so perpetually under revision and correction, that it is extremely hard to extract from it any convincing proof of any of Eddington's most famous formulæ. When I say "brilliantly written", I mean that it is enlivened with sallies of a most vivid description in nearly every chapter, showing how the unregenerate Eddington kept up his spirits and his self-confidence to the very end in spite of all the criticisms he incurred; as, for example, when he writes (p. 189) "to deny that a neutron is composed of a proton and an electron is as pedantic as to deny that water is composed of oxygen and hydrogen"; or (p. 162) "broadly speaking there is no three-particle theory in physics"; or (p. 131) "the only kind of individuality known in physics is the pseudo-individuality conferred by idem-potency"; or (p. 30) "the term particle survives in modern physics but very little of its classical meaning remains"; or (p. 19) "quantisation is a distinctively *electrical* phenomenon"; or (p. 89) "the initial fallacy in recent investigations of white dwarf matter . . . continues to work devastation in astronomy"; or (p. 76) (a remark I strongly object to, as in making it Eddington was behaving like an ostrich) "the infinite universe has long been dead and buried; and those who insist on digging up the corpse must expect to be haunted".

To come to more serious criticisms. Those who seek a compact proof that the fine-structure constan $2\pi e^2/hc$ has the exact value 1/137 will have a very difficult time of it in this book. One first has to master the use Eddington makes of his multiplicity factors k, which are somewhat disarmingly defined as the number of dimensions of a certain phas space; then his procedure of *stabilization*, which i a sort of wand which he waves in order to suppres inconvenient degrees of freedom, and so to alter the multiplicity factors; then one has to overcome all one's prejudices in swallowing a formula on p. 29, that masses are *inversely* as multiplicity factors, whereas, with Eddington's repeated identification of mass with energy, one would have expected the energy of a particle to be directly, not inversely, proportional to the number of its degrees of freedom in phase space. After these troublesome preliminaries one reads to §20, entitled "The Fine-Structure Constant", only to find that there merely plausible considerations are advanced for the assignment of the number 137 to the ratio of two "atoms of action", and that the theoretical derivation of the relation is postponed to §33. Lastly, one cannot follow §33 at all. These difficulties re-occur throughout the book.

Still severer criticism must be made of one of Eddington's derivations of what he calls "the central formula of unified theory" (p. 81, equation 40.8). This is the formula:

$$M = \frac{136}{10}\,\frac{3}{4}\,\beta^{1/6}\,\frac{h}{2\pi}\,\frac{\sqrt{(4/5)N}}{\cdot cR_0},$$

where 136 and 10 are multiplicity factors, β is the "Bond factor", M is the mass of the hydrogen atom, R_0 is the radius of the Einstein spherical universe, and N $(=3/2.136.2^{256})$, the cosmical number, is the number of protons and electrons in the universe. He first derives the formula by considerations involving various fictitious particles—the standard carrier, extracules, intracules, hydrocules. These arguments I cannot follow. He then remarks: "in the next three sections the same formula will be derived by an entirely different method". This method is an application of one of his aphorisms, "exclusion is a wave-mechanical substitute for gravitation", and one's spirits begin to rise, because the method consists in applying to the *uranoid*, or neutral Einstein universe, the Pauli exclusion principle as used, for example, in the Thomas–Fermi atom, or in the determination of the equation of state of a degenerate gas, as applied to super-dense stars, and with this, at least, an astrophysicist is familiar. Eddington does, in fact, apply the usual method, of filling cells in phase space, and one expects to see the 'central formula' emerge. Unfortunately for Eddington's aphorism, it emerges with the wrong power of N, in fact with an extra unwanted factor $N^{1/3}$, which makes nonsense of the so-called independent derivation. But Eddington is not one whit abashed. He calmly puts $\mu_1 = \mu_0(\frac{3}{4}N)^{1/3}$, where μ_0 is the mass-constant of an extracule, and presents us with a formula, (41.41), supposed to be equivalent to the central formula, but with the unwanted power of N absorbed into one of the symbols. It is difficult to understand how Eddington could convince himself that this palpable fudge amounts to an independent proof of his 'central formula' by the 'gravitation equals exclusion' principle. But when Eddington had the bit between his teeth, no mere mathematical inconsistency ever held him back: witness, for example, his erroneous treatment of stellar opacity, as I have shown elsewhere.

Eddington's 'uranoid' plays the same part in his theory as the 'substratum' in kinematical relativity. In both theories it is an idealized model of the smoothed-out universe, and as such is the environment, the scene, the stage upon which phenomena are enacted or objects isolated. But whereas the substratum unchangingly incorporates the essential element of expansion, or recession, Eddington's uranoid is static—non-expanding and at zero temperature. Eddington admits (p. 93) that both his uranoid and another environment he introduces called 'the planoid' "differ widely from the actual expanding universe". Eddington has been, in fact, inclined to criticize notions which competed with his own, and then, no doubt unconsciously, develop similar notions in his own work. Another example: on p. 14 he correctly explains that by adopting two conventions as to units, namely, $c = 1$ and $8\pi\kappa(h/2\pi)^2 = 1$, he is left with one unit at his disposal, "which may be taken to be a length, mass, density or any other combination". "If, for example, it is taken to be a length", every physical quantity has a single dimension index which shows how it varies with the unit of length. But why did he not go on to admit that it might be taken to be a *time*? Why did he unsparingly criticize and reject my own similar procedure when I made physical quantities depend only on the unit of time?

His actual reason for taking $c = 1$ is perverse and misguided: "by taking the velocity of light to be unity, we avoid the obsolete and troublesome distinction between mass and energy" (p. 14). It is as though one should justify measuring pressures in centimetres on the ground of avoiding the obsolete and troublesome distinction between pressure and length. The treatment of energy as mass obscures the fundamental fact that energy has to be defined through mechanical work, and the whole theory of the momentum-energy 4-vector shakes visibly as soon as we see that energy is really a 4-scalar, as is necessary (among other reasons) for the conservation of energy to have a meaning.

Leaving aside these criticisms of detail, one has to pass some general judgment on the work as a whole. It must be recognized that Eddington has invented a mathematical technique, a logic of reasoning and a language of formulation which are as yet strange to most of us, and which no doubt conceal arguments and considerations which would be accepted if less individually expressed. That his work runs counter to some of current physics he was well aware. The antagonism is evident from the outset of the book (p. 9), for he treats the non-Coulombian energy of two electrical particles as Ae^{-r^2/k^2}, while on Yukawa's formulation and on kinematic relativity exponential terms of the type $e^{\pm e^2/mc^2r}$ are involved (*Phil. Mag.*, 34, 244; 1943). Thus the whole use which he makes of the Gaussian theory of errors is out of line with current electrical theory. Nevertheless, the agreements he gets with the observed constants of Nature are impressive, though (to my mind) calculating the recession-speed of the galaxies is only equivalent to calculating the age of the universe at the moment we happen to be viewing it. I think that Eddington's repeated insertions of lists of constants calculated from 'fundamental theory' were made more to convince his critics than because he himself attached over-riding importance to them. It was the landscape of his theory that most appealed to him. Witness, for example, his beautiful geophysical analogy (p. 220): "The term uranoid was derived from analogy with the geoid; the field momentum and energy is the isostatic compensation of the mountains (object particles) added to the uranoid. We have not hitherto used this analogy because geodesy is not accustomed to deal with mountains which are 'unidentified members of a large assembly'. But we are now preparing, formally at least, to deal with individual mountains; and an important step is as far as possible to attach to each individual its own isostatic compensation, instead of the collective compensation that suffices in scale-free physics. . . . The wave-function is a self-contained unit which can be dumped anywhere on the uranoid without upsetting the equilibrium of the uranoid particles."

Eddington's last scientific testament has all the marks of the production of a man of genius, not excluding tiresomeness; whether or no it will survive as a great scientific work, it is certainly a notable work of art. E. A. Milne

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TECHNICAL AND SCIENTIFIC ASPECTS OF ATOMIC ENERGY

Science News, 2

Atomic Energy Number. Edited by Prof. R. E. Peierls and John Enogat. Pp. viii+168+15 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1947.) 1s. net.

MUCH has appeared in print and been heard in recent weeks about atomic energy; but an authoritative survey of the technical and scientific development of the past few years in the field of nuclear physics is still lacking. The second volume of Penguin Science News is, therefore, very welcome, because it is a collection of seven articles, written by prominent nuclear scientific workers, covering some of the more important technical and scientific aspects of the subject of atomic energy. The question of international control, and the political and social consequences are not dealt with specifically. The authors, some as members of the British and others of the American staff, were at one time engaged together on the atomic bomb project at Los Alamos, and thus write with first-hand knowledge of the problems which were tackled and solved in the production of atomic energy for military purposes. Each of the seven articles is self-contained and may be studied separately.

The subject-matter is presented in an interesting fashion, and can be readily understood by the non-specialist but scientific reader. The first article, by Prof. R. E. Peierls, is a general survey of the whole field and forms a key to the rest. H. A. Bethe follows with a description of the structure of atoms and nuclei, and H. L. Anderson shows how atomic power was tamed and plutonium produced. "The Physics of the Bomb", by P. Morrison, gives not only a clear description of the chain reactor which constitutes the atomic bomb, but also a very vivid picture of what happens during and immediately after the explosion. Some of the peace-time applications of the liberation of nuclear energy using radioactive tracers are dealt with by M. Argo and E. Teller, and in the final article O.R. Frisch reviews, with numerous diagrams, some of the techniques used in nuclear research.

Considering the high price of present-day scientific text-books, it is remarkable that this collection of articles can be produced for so small a cost as one shilling. It is true that the diagrams, though clear, are too small and that the plates leave much to be desired both from the point of view of subject and reproduction; but these are very minor defects in a book which, undoubtedly, will be widely read and which will be in great demand—probably in greater demand than the limited supply will be able to satisfy. S. Weintroub

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D.D.T. FROM AN AMERICAN POINT OF VIEW

D.D.T. and the Insect Problem

By James C. Leary, Dr. William I. Fishbein and Lawrence C. Salter. Pp. vii+176. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 12s. 6d.

THE insecticidal property of D.D.T. was undoubtedly a great discovery, and its application during the War, at a time when the supplies of other insecticides were inadequate after the capture by the Japanese of the derris-producing areas and the cutting off of supplies of pyrethrum, was an important contribution to Allied victory. D.D.T. will have many uses in peace-time, and it is therefore important that its properties should be widely known so that it may be used to the best advantage. In Britain the book "D.D.T.: the Synthetic Insecticide" (reviewed in *Nature*, 158, 359; 1946), by West and Campbell, was generally welcomed; the authors have been themselves engaged in insecticide research, and have made important contributions to knowledge concerning D.D.T. Now a book on apparently similar lines comes from the United States. Its authors are not research workers; one is a medically qualified epidemiologist, but from internal evidence one judges that the book was mainly written by his colleagues, who are both journalists. Although the book looks at first sight as if it were a scientific compilation, it is in fact popularized journalism with some scientific data thrown in rather uncritically for effect.

D.D.T. was first used in Switzerland, and many of the 'classical' experiments were carried out in that country. Later, during the War, a great deal of experimental work was done both in the United States and in Britain. Unfortunately, the British authorities were rather more reluctant than the American to allow publication of the results of this work, so the literature contains a preponderance of American papers. Nevertheless, many important British contributions have been published. In West and Campbell's book the bibliography is reasonably complete up to 1945, when it went to press; there are many Swiss and British references, but the majority listed are American. Leary, Fishbein and Salter also publish a bibliography. It contains no references to Swiss work (they do acknowledge in the text that a little preliminary research was done in Switzerland), and the only British contributions appear to be three short notes in the *British Medical Journal* describing cases of individuals poisoned by excessive exposure or by drinking D.D.T. solutions. Every other reference is American.

Notwithstanding its trans-Atlantic bias, "D.D.T. and the Insect Problem" might still be a useful book if it were an accurate and readable summary of current knowledge. It is not. It contains many sweeping and controversial statements; thus, for example, infectious encephalitis (confusingly called "Sleeping Sickness") is definitely stated to be carried by a culicine mosquito. Its style may be gathered from a typical quotation, from the section on typhus control: "Neapolitan brides finally got so they laughed when D.D.T. replaced rice at weddings". So much first-class research has been done in the United States on D.D.T., and there are so many good 'popularizers' in that country, that it is a pity that a better book has not been produced to fill what must be a widely felt need.

Kenneth Mellanby

EXPERIMENTS ON THE STIMULATION OF CLOUDS TO PRODUCE RAIN

By E. B. KRAUS and P. SQUIRES

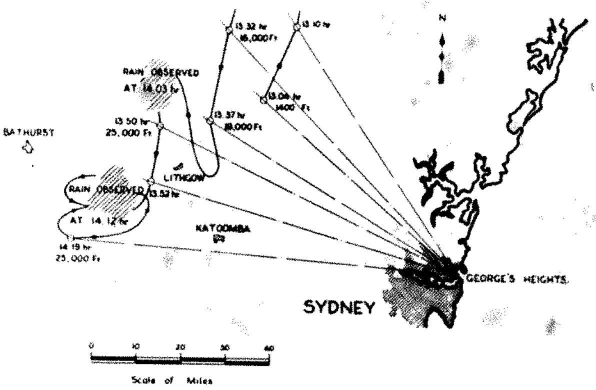
Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia

IN 1933 Bergeron[1] postulated that rain falls only from clouds which contain both water drops and ice crystals. Natural cumulus clouds at temperatures above −13° C. often contain only supercooled water drops and no ice crystals. If a method existed of planting crystal 'germs' in these clouds, the crystals would grow into large snowflakes at the expense of the water drops and eventually fall as rain or snow.

During a visit to Schenectady in July 1946, one of us had the opportunity of witnessing Schaeffer's experiments in which ice crystals were produced artificially in the laboratory by the sudden cooling of moist air[2]. These experiments can be related to a quantitative theory which has been developed by Volmer[3]. They suggested a possible method of planting ice particles in natural clouds. Newspaper reports since that date have indicated that Langmuir and Schaeffer have succeeded in stimulating the precipitation of snow from supercooled clouds by dropping 'dry ice' pellets into them from aircraft.

Experiments have now been carried out in Australia with the view of investigating the artificial stimulation of rain. At the time of writing eight different clouds have been treated. Radar observations have indicated that rain formed inside the cloud on six occasions, and on four of these heavy rain was observed visually to reach the ground. One case is doubtful; and a single negative result was obtained when a cloud, which reached only about 1,000 ft. above freezing-level, was infected. All other clouds had a vertical extent of more than 10,000 ft., of which at least 4,000 ft. were above freezing-level.

One of the most spectacular tests was carried out on February 5, 1947. On that day equatorial air was flowing slowly over the east coast of Australia from a generally north-easterly direction. Inland areas of eastern New South Wales were covered by seven- to eight-tenths of cumulus cloud (Fig. 1). The coastal plain and the Pacific were cloudless, as seen in the background on Fig. 2. The cloud base was at 11,000 ft., the freezing-level at 18,000 ft. and the top of the clouds uniformly at 23,000 ft.



RADAR PLOT OF THE AIRCRAFT TRACK AND THE TWO AREAS WHERE RAIN ECHOES WERE OBSERVED TO FORM

At 13.45 hr., 100 lb. of granulated carbon dioxide was dropped into a cloud the top of which was slightly below the general level. After five minutes, no visual results were observed. The aircraft flew on, and another test was carried out about twenty miles to the south-west. At 13.56 hr. 150 lb. of 'dry ice' was dropped into a second cloud. The aircraft circled, and in less than five minutes rain echoes from within the cloud were recorded on the aircraft's 10 cm. radar equipment. After the release of a further 150 lb. of 'dry ice', the echoes grew in intensity, and twenty-one minutes after the cloud was first infected an oblique view was obtained which showed heavy rain coming from the base of the cloud. Forty-five minutes later the aircraft descended to 8,000 ft., well below the cloud base, and a pillar of rain covering at least twenty square miles was then seen to reach the ground. Later interrogation of farmers in that vicinity confirmed the occurrence of an isolated rain storm.

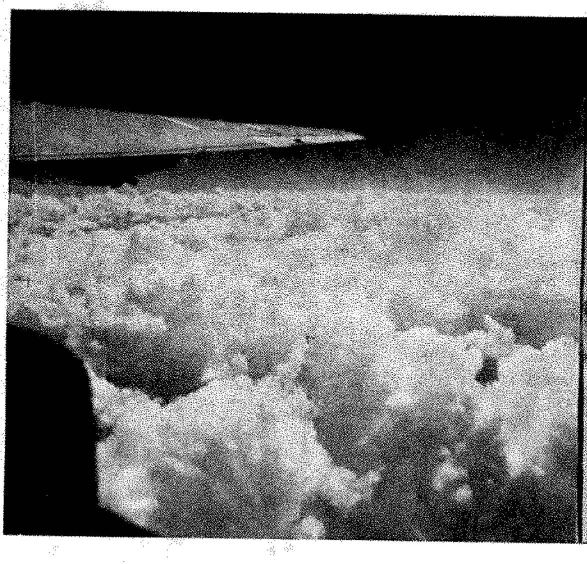


Fig. 1. INLAND CLOUD TYPES BEFORE 'DRY ICE' WAS DROPPED

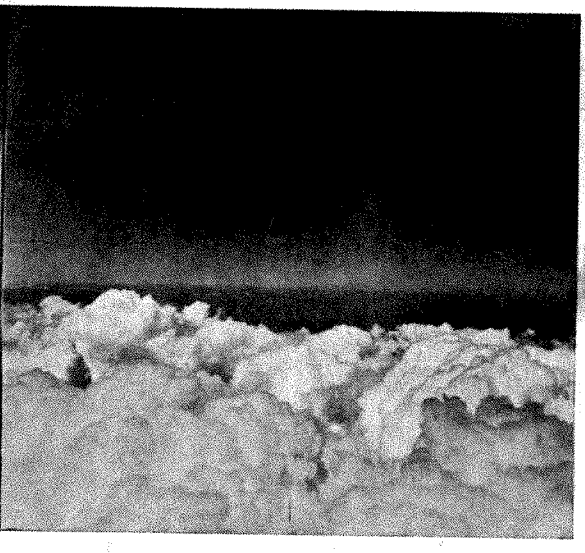


Fig. 2. GENERAL SITUATION LOOKING EAST OVER THE PACIFIC

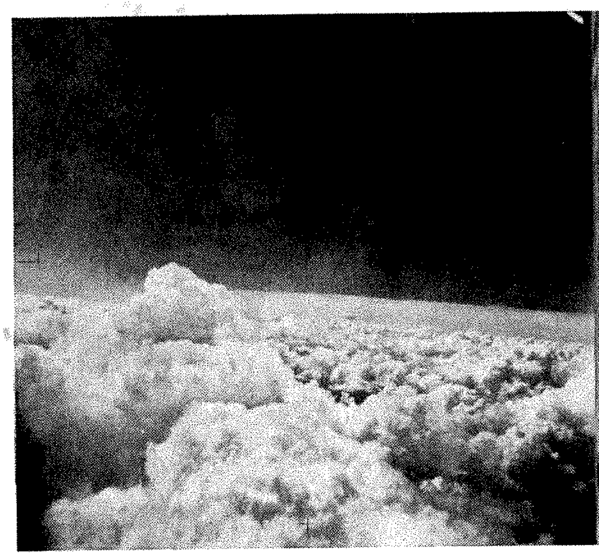


Fig. 3. NINE MINUTES AFTER THE RELEASE OF 'DRY ICE'

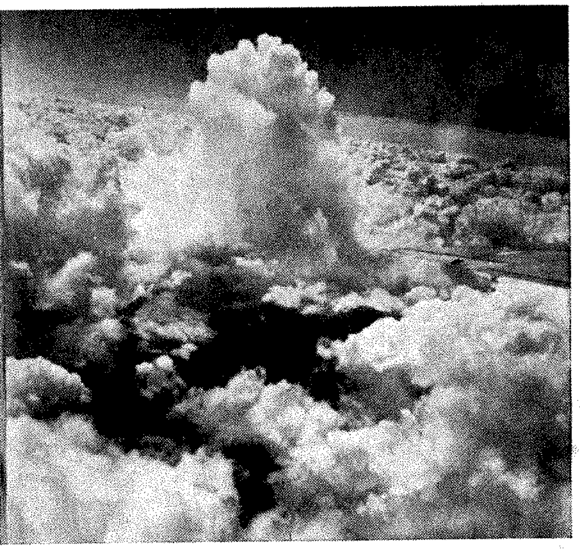


Fig. 4. THIRTEEN MINUTES AFTER THE RELEASE OF 'DRY ICE'

The flight was observed by a 25 cm. radar set at George's Heights in Sydney. The accompanying radar plot gives the measured position and height of the aircraft at different times. The track taken by the aircraft, while circling the dropping zones, has been omitted. Rain echoes appeared on the radar screen in the area of the first drop at 14.03 hr., that is, 18 min. after the release of 'dry ice'. In the second dropping zone, rain echoes were first sighted at 14.12 hr., or 16 min. after the release. It persisted for the rest of the afternoon. No other rain was observed within 100 miles of the aircraft.

Visual observation above the clouds showed a spectacular growth of the second infected cloud. Figs. 3 and 4 give its aspect 9 min. and 13 min. after the dropping. Later, a narrow towering anvil formed (Figs. 5 and 6). Another smaller tower was seen approximately in the direction where the first drop had been made. These were the only two clouds which rose above the general level of the other tops. It is estimated that the bigger one reached a height of perhaps 40,000 ft. The line of frontal clouds, which can be seen along the horizon on some of the photographs, was about 180 miles to the south.

The remarkable rise of the infected cloud may have been due to the liberated heat of fusion. The atmosphere above 23,000 ft. was presumably unstable for changes involving the transformation from vapour to ice (saturated adiabatic relative to ice), although it was stable with regard to condensation processes (saturated adiabatic relative to water). We do not know how frequently such atmospheric conditions occur.

It is emphasized that the meteorological conditions chosen were those which we believed to be most favourable. Before practical application of the results is possible, it will be necessary to establish the minimum conditions and to find out how often they are likely to occur. The phenomenon is related to the temperature distribution, the available amount

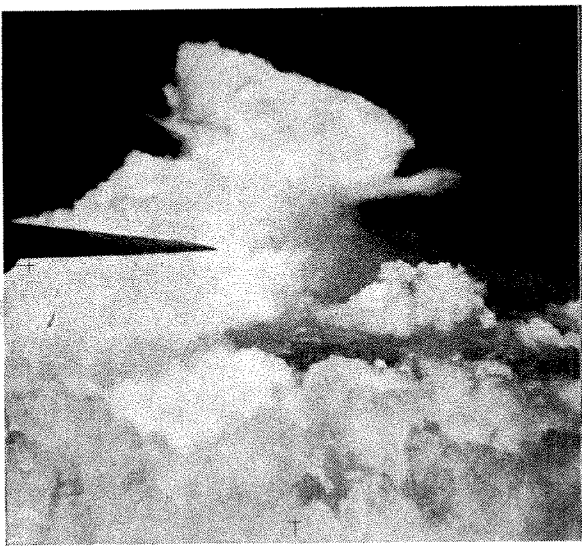


Fig. 5. THE SMALL ANVIL WHICH FORMED AFTER ABOUT TWENTY MINUTES

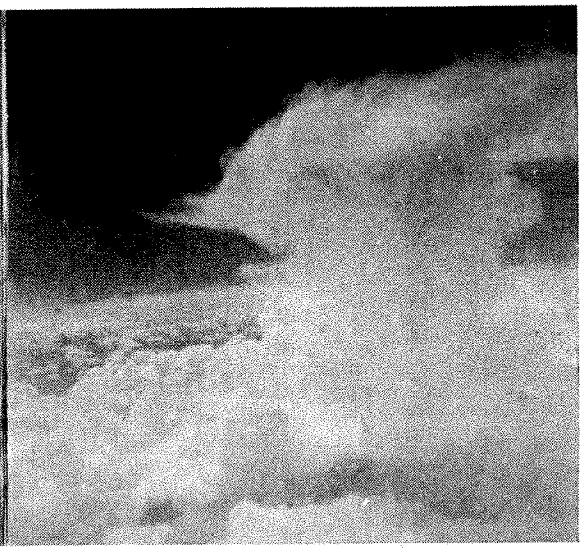
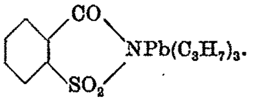


Fig. 6. THE FULLY DEVELOPED ANVIL

tion. Its solubility in alcohol was high (65 gm. dissolved in 100 c.c. of cold alcohol). The compound could be recovered unchanged from the alcoholic solution after six days.

A large variety of compounds of the type $RSO_2NR'PbR_3''$ were then prepared[9,10], where, for example, $R = CH_3$, C_6H_5, p-$NH_2C_6H_5$, and $R' = H$, C_6H_5, p-ClC_6H_4, p-BrC_6H_4, and $R'' = C_2H_5$, n-C_3H_7, etc. They were without exception good sternutators, with tri-n-propyl lead methane sulphonamide as the most potent, being extremely unpleasant at a concentration of 1 in 25,000,000. It possessed a further advantage on account of its relatively low molecular weight.

One of the most interesting compounds of this series was tri-n-propyl lead o-sulphobenzimide[9] (I), which produced intense irritation and caused the



(I)

observers to leave the chamber after 1½ min. exposure. We reported, also, that the compound, even at this dilution, produced a 'sweet taste'.

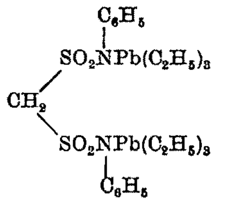
In view of the fact that the sulphonamide grouping on one hand and an unsaturated grouping on the other hand (for example, triethyl lead acrylate and tri-n-propyl lead acrylate) each independently produced an increase in sternutatory effect, it was decided to prepare triethyl lead vinyl sulphonanilide (II):

$$CH_2 = CHSO_2N(C_6H_5).Pb(C_2H_5)_3.$$

(II)

The compound was certainly one of the best sternutators of the triethyl lead series, and at a concentration of 1 in 10^7 gave an atmosphere which was scarcely tolerable. The potency, however, was not so high as might have been anticipated in view of the presence of two 'active' groups[9].

About this time we also prepared and tested methylene bis(triethyl lead sulphonanilide) (III)



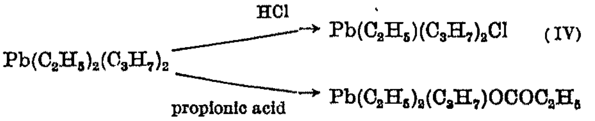
$$CH_2\left[SO_2N(C_6H_5)Pb(C_2H_5)_3\right]_2$$

(III)

Although it was a reasonably good sternutator, its properties were in no way outstanding.

Trialkyl Lead Salts from 'Mixed' Plumbanes

Our work indicated that derivatives of mixed plumbanes possessed rather more pronounced sternutatory properties than did the simple plumbanes. By the reactions outlined in the following scheme, derivatives of diethyl di-n-propyl lead have been made[11,12]. It appeared that a strong acid eliminated one propyl group, whereas a weak acid eliminated one ethyl group.



$$Pb(C_2H_5)_2(C_3H_7)_2 \xrightarrow{HCl} Pb(C_2H_5)(C_3H_7)_2Cl \quad (IV)$$

$$Pb(C_2H_5)_2(C_3H_7)_2 \xrightarrow{\text{propionic acid}} Pb(C_2H_5)_2(C_3H_7)OCOC_2H_5$$

From ethyl di-n-propyl lead chloride (IV), the corresponding ethyl di-n-propyl lead p-toluene sulphonamide was prepared. By the second type of reaction diethyl n-propyl lead propionate and monochloroacetate were prepared.

Aromatic Compounds

Finally, it may be noted that triphenyl lead chloride, triphenyl lead bromide and triphenyl lead iodide were found to be devoid of sternutatory properties[9] at the concentrations employed in our experiments, that is, at concentrations of the order of 1 in 10^6.

Analysis

The preparation of many hundreds of lead organo-lead compounds necessitated the use of a rapid and reliable method of estimating the percentage of lead in such compounds, particularly as carbon and hydrogen analyses were often incorrect. In outline, the method which we employed[3] consisted in digesting the organic compound in concentrated nitric acid, adding ammonia, and then acetic acid. The lead was then precipitated as lead chromate, which was dissolved in dilute hydrochloric acid, and titrated with ferrous ammonium sulphate solution, using ferrous phenanthroline as internal indicator.

Other Organo-metallic Compounds

In addition to the preparation and examination of the lead compounds mentioned above, we also examined organic compounds containing tin, bismuth, thallium and mercury with the view of obtaining a compound having powerful sternutatory properties[9]. It should be emphasized that these metals were in short supply at the time, and only a compound of outstanding potency would have been of any value.

Briefly, the results were as follows. In general, alkyl-tin salts were found to be only feeble sternutators. Triphenyl tin iodide, $(C_6H_5)_3SnI$, however, was found to have sternutatory properties and to be intolerable at a concentration of 1 in 10^6. This was rather unexpected in view of the fact that the corresponding compound in the lead series, namely, triphenyl lead iodide, is devoid of sternutatory properties. This led us to prepare the following triphenyl tin compounds[9,10], none of which had previously been described:

$(C_6H_5)_3SnCH_2COOEt$, $C_6H_5SO_2NHSn(C_6H_5)_3$, and $(C_6H_5)_3Sn.O.COCH_2COEt$.

As sternutators they were useless.

In April 1941 we prepared diphenyl bismuth propionate, bromoacetate, and iodoacetate[11,12]. These were barely tolerable at a concentration of 1 in $2 \cdot 5 \times 10^7$, and unpleasant after-effects were produced. These compounds, however, were difficult to recrystallize. Diphenyl bismuth chloride, bromide and cyanide were prepared according to known methods, and on testing in the chamber proved to be very good sternutators[11,12], and were probably slightly more powerful than *D.A.* (diphenyl chloroarsine).

Also in 1941 we prepared diethyl thallium bromide, diethyl thallium iodide, diethyl thallium acetate and diphenyl thallium acetate according to known methods. Chamber experiments revealed that they were undetected by human observers at concentrations of 1 part in 10^7.

Similarly, the following mercury compounds were devoid of sternutatory properties, but produced a garlic-like odour at a concentration of 1 part in 10^7:

methyl mercuric iodide, methyl mercuric hydroxide, *n*-propyl mercuric chloride and phenyl mercuric iodide.

Summary

A large number of organo-lead compounds have been prepared and tested as potential sternutators at Cambridge. They have been examined at nominal concentrations (for example, 1 in 1,000,000, 1 in 10,000,000 and 1 in 25,000,000) in a 10-cubic metre chamber, the material being dispersed by spraying a solution in alcohol or ether. Four observers (members of the team) entered the chamber for each experiment.

From the results of the experiments, the compounds were placed in various categories with reference to triethyl lead chloride as an arbitrary standard. It has been established in respect of sternutatory power that:

(1) Salts of the trimethyl lead, $(CH_3)_3Pb^+$, series are markedly inferior to those of the triethyl lead, $(C_2H_5)_3Pb^+$, series.

(2) Salts of the tri-*n*-propyl lead series are superior to the corresponding compounds in the triethyl series. In fact, there appears to be a peak of activity in the tri-*n*-propyl series, derivatives of tri-*n*-butyl lead and above exhibiting diminishing activity.

(3) Derivatives of the monovalent ion (for example, $(C_2H_5)_3Pb^+$) are greatly superior to derivatives of the divalent ion (for example, $(C_2H_5)_2Pb^{++}$).

(4) Within a given series, salts of organic acids (for example, the acetate or acrylate) are usually superior to salts of inorganic acids (such as the chloride). The β-chloropropionates and acrylates are particularly potent.

(5) A new series of substituted sulphonamides of the type $RSO_2NR'PbR''_3$ has been synthesized. These are of particular interest. They are easily prepared and are powerful sternutators. As in other series, the tri-*n*-propyl lead derivatives are the most potent, and tri-*n*-propyl lead methane sulphonamide is only slightly less potent than the best arsenicals.

We are indebted to the Chief Scientist, Ministry of Supply, for permission to publish the above. We are grateful to Mr. Davidson Pratt for the interest that he has shown in the work, and also to the Chemical Defence Research Departments, Ministry of Supply, in London and at Porton.

The following took part in these investigations at Cambridge.

H. McCombie B. C. Saunders
D. Faulkner B. A. Kilby F. Wild
R. Heap G. J. Stacey S. J. Woodcock
F. E. Smith

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[1] Krause and Pohland, *Ber.*, 55, 1282 (1922).

[2] Gilman and Robinson, *Rec. Trav. Chim.*, 49, 766 (1930).

[3] McCombie, H., and Saunders, B. C., Report to Ministry of Supply, October 22, 1940.

[4] McCombie, H., and Saunders, B. C., Summary to Ministry of Supply up to October 31, 1940.

[5] McCombie, H., and Saunders, B. C., Report to Ministry of Supply, Oct. 31–Dec. 31, 1940.

[6] McCombie, H., and Saunders, B. C., Summary to Ministry of Supply, Oct. 31–Dec. 31, 1940.

[7] McCombie, H., and Saunders, B. C., Report to Ministry of Supply, Jan. 1–March 31, 1941.

[8] McCombie, H., and Saunders, B. C., Summary to Ministry of Supply, Jan. 1–March 31, 1941.

[9] McCombie, H., and Saunders, B. C., Report to Ministry of Supply, April 1–June 30, 1941.

[10] McCombie, H., and Saunders, B. C., Summary to Ministry of Supply, April 1–June 30, 1941.

[11] McCombie, H., and Saunders, B. C., Report to Ministry of Supply, July 1–Aug. 25, 1941.

[12] McCombie, H., and Saunders, B. C., Summary to Ministry of Supply, July 1–Aug. 25, 1941.

SOCIAL MEDICINE AND SOCIAL PATHOLOGY

By Dr. IAGO GALDSTON
New York Academy of Medicine

THE centenary celebration of the New York Academy of Medicine was initiated with a dinner-meeting at the Waldorf-Astoria Hotel on March 6, 1947. Twelve hundred fellows and friends of the Academy gathered in the main ballroom of the hotel and, after dinner, listened to the addresses of the president of the Academy, Dr. George Baehr, and of the guest of honour and principal speaker, Prof. John A. Ryle, professor of social medicine in the University of Oxford.

Dr. Baehr, in his presidential discourse, reviewed the history of the Academy and outlined its anticipated developments in the near future. Prof. Ryle, in his address, discussed the meaning and significance of social medicine and social pathology. Prof. Ryle's address was particularly pertinent in the light of the four-year study which has been conducted by the Academy's Committee on Medicine and the Changing Order. The report of this Committee is to be published shortly.

There is a fairly widespread appreciation in the United States that a substantial number of those items in medical care about which there has been so much discussion (labelled here as "socialized medicine") must and will find a solution in the application of the philosophy and techniques advanced under the head of social medicine.

Prof. Ryle drew upon his thirty years of clinical experience in medicine to bring into prominence the deficiencies in the current teaching and practice of remedial medicine. "I have watched," Prof. Ryle said, "disease in the ward being studied more and more thoroughly—if not always more thoughtfully—through the higher power of the microscope; man in disease being investigated by more and more elaborate techniques and, on the whole, more and more mechanically. Man, as a person and a member of a family and of much larger social groups, with his health and sickness intimately bound up with the conditions of his life and work—in the home, the mine, the factory, the shop, the official on the land—and with his economic opportunity, has been inadequately considered in this period by the clinical teacher and hospital research worker.

"The morbid 'material' of the hospital ward consists very largely—if we exclude the emergencies—of end-result conditions for which, as a rule, only a limited amount of relief repays the long stay, the patient investigation and the anxious expectancy of the sick man or woman.

"With etiology—the first essential for prevention—and with prevention itself the majority of physicians and surgeons have curiously little concern. Nor have they at present the opportunity, nor yet the appropriate types of training or assistance, requisite for the study of etiology or prevention. Their material is mainly selected by four factors: the gravity, the difficulty or the rarity of their cases, or their suitability otherwise for admission to a hospital. Some of the most common diseases, the less lethal diseases and the beginnings of disease are even considered as providing 'poor teacher material'. Health and sickness in the population and their possible correlations with significant and measurable social or occupational influences are outside their province."

Prof. Ryle then cited in illustration a number of diseases, including gastric and duodenal ulcers, which it is not likely that we will master "until we study the victims of the disease at first hand and in relation to their work, their total occupational experience, their communities, their food, their habits and anxieties, and their innate predispositions".

These procedures involve the development of the science of 'social pathology' and 'hygiology', for "the study of the ultimate causes of disease—without which the specific factors can never find their opportunity—goes hand in hand with the study of the causes of health, and how much we have still to learn of the meaning and measurement of health".

Prof. Ryle further defined social pathology as "the medicine and pathology of families, groups, societies or larger populations. Just as human pathology is the related science of clinical medicine—so may social pathology be viewed as the related science of social medicine. Social medicine embraces, on the one hand, the whole of the activities of the public health administration and of the remedial and allied social services, and, on the other, the special disciplines necessary for the advancement of knowledge relating to sickness and health in the community".

Prof. Ryle emphasized the pertinence of his plea, quoting Julian Huxley, who has described current events as a "transition now in progress from the age of 'economic man' to the age of 'social man'. Our profession which is so particularly concerned with man and his welfare," said Prof. Ryle, "must assist this transition with all the scientific and humanist wisdom at its command. Hitherto, our science, like our practice, has evolved along individualist lines. Whatever the several countries may do with regard to the modification of their systems of practice and of service, it seems to me that the scientific study of health and disease in man—the most complex of all social animals—must henceforward concern itself to an ever-increasing degree with the interactions and correlations of disease and health with changing social circumstances. Socially, industrially, politically, we are creating a new age. With it, inevitably, we alter the whole character and distribution of diseases and set ourselves new problems for solution in the fields of medical science, practice and administration."

Prof. Ryle's thesis fitted in very appropriately with the general spirit of the centennial celebration of the New York Academy of Medicine and served as a splendid introduction to the 'Institutes' that have been planned as a part of the centenary celebration; notably the Institutes on Social Medicine, Public Health, and Medical Education. He took part in the Institute on Social Medicine during March 19, 20 and 21, the sessions of which were devoted to the discussion of the following topics: The Changing Concepts of the Relation of Medicine to Society; Social Medicine—Its Differentiation From and Relation to Clinical and Preventive Medicine; Epidemiology in Social Medicine; The Place of Nutrition in Social Medicine; Social Psychiatry and Social Medicine; Social Applications of Psychiatry. The Institute ended with a dinner meeting on March 21, at which Lord Horder, consulting physician to St. Bartholomew's Hospital, London, delivered an address on "Social Medicine: The Appeal of the Common Man".

OBITUARIES

Prof. Pierre Janet

PIERRE JANET, who died in Paris on February 24 at the age of eighty-seven, played a notable part in the development of clinical psychology. He took a degree in philosophy in 1882, and some of his best work was done before taking his degree in medicine eleven years later. He held various academic posts before becoming a professor at the Sorbonne, and was for a time in charge of the psychological laboratory attached to the Sâlpetrière Clinic. It is not easy to trace his personal relationship with Charcot at that period, and their fundamental attitudes were very different. Thus, in his account of the controversy (c. 1886) when Bernheim showed that Charcot's phenomena of hysteria and hypnotism were artefacts, "the results of unskilled suggestion and involuntary training", he wrote ("Principles of Psychotherapy", trans., London, 1925; p. 30): "The victory of the animists was not well received, at least in the scientific world. They acknowledged it but deplored it. The doctrine of Charcot that it defeated was clear, definite, and easy to study; it seemed to bring animal magnetism within the limits of physiology, and that looked like scientific progress."

In 1889 Janet wrote "L'Automatisme Psychologique", in which his conception of dissociation of consciousness subsumes under one formula such apparently disparate manifestations as water-divining, mediumism, the bodily symptoms of hysteria, amnesias, fugues and somnambulisms. In view of the persisting popular belief in the dowser's rod it may be noted that, after describing its use in the pursuit of criminals and the finding of buried treasure, he wrote: "Il est probable que, dans quelques campagnes, subsiste encore la croyance aux révélations de la baguette divinatoire". As a description of what may be supposed to happen in the superficial layers of the mind the theory of dissociation is not incompatible with psychoanalysis, which Janet, however, was not able to accept. In "Les Obsessions et la Psychasthénie", written jointly with F. Raymond in 1903, scarcely any of the bizarre symptoms of these conditions escape recognition. Many are described for the first time, and the writers were a generation ahead in many observations, such as the recognition of writers' cramp as a psychogenic disorder. It is a pity that Janet's word 'psychasthenia' has fallen into disuse, for it avoids the metaphysical assumptions involved in the use of such words as 'neurasthenia' or 'neurosis' to denote pathological mental states.

Much of Janet's writing has been translated and published in Britain and in America. Running through all is an emphasis upon the history of psychopathology, which helps in the understanding of some fundamental differences of opinion that still exist. It must be admitted that his work received little recognition from the medical profession in France, for the spirit of the times was not yet in accord with his psychological approach. In the First World War the French were quick to recognize the importance of psychoneuroses in soldiers; but in their plentiful literature on the subject there seems to be no reference to his teachings. In Great Britain, however, the application of his work on amnesia threw light upon these conditions, and in the Second World War the use of pentothal in the revival of war memories was a tribute to his observation that "ether, chloroform, and ethyl chloride have been used to bring about hypnotic sleep with some interesting results" (*loc. cit.*, p. 134).

Outside the medical world, however, Janet received full recognition, becoming president of the Academie des Sciences Morales et Politiques, while to many Parisians he was affectionately known as 'Papa Janet'. Last autumn, in spite of his years, he travelled to Zurich and delighted a psychological congress with the charm and erudition he showed in an extempore address. His work is now rather overshadowed by the developments of psychoanalysis, but he stands out as the pioneer who, almost single-handed, brought psychology into practical alliance with medicine.

MILLAIS CULPIN

Dr. A. H. Jay

THE tragic death of Dr. A. H. Jay on February 27 at the age of forty removes one of the most colourful characters from the ranks of X-ray workers in Great Britain. At conferences and discussions one could always be sure that Dr. Jay would present a novel aspect of whatever problems were being aired, and he presented it with a vigour that was characteristic of the man. His pronounced north country accent and his use of personal reminiscences gave his lectures a spice and flavour out of the ordinary.

Those who knew him on more intimate occasions knew also that his originality was not reserved for the lecture room; it manifested itself in many different ways, in research and in committee meetings. As a member of the committee of the X-ray Analysis Group of the Institute of Physics, Jay was a staunch advocate of individuality, and strongly opposed those of us who wished to introduce more standardization into X-ray matters; he had designed and built most of his own X-ray equipment, and he did not see why the coming generation of research workers should not do the same. What he did not realize was that so few were possessed of his energy and initiative, his ability to overcome obstacles. As an example, his high-temperature camera might be cited. Jay designed this camera at Manchester and did much useful work with it; yet, after he left, nobody produced any results with it. The reason for this was obvious: there were so many points in it that had to be attended to at once that only Jay could manage to look after them all!

Jay's qualities were particularly well suited to the type of research work he undertook. His work with Bradley on superlattice formation in the iron–aluminium system is accepted as a model of completeness, and has been the basis of much theoretical investigation. It involved a quantity of measurement that would have daunted a lesser man, but work seemed to give Jay an appetite for more. This quality stood him in good stead in his work for industry, which involved the taking of large numbers of X-ray photographs of refractories. The interpretation of these photographs and the analysis of the results obtained from them enabled him to make many important fundamental contributions to the study of these materials, and it is probably true to say that the main importance of these contributions has yet to be seen.

It is sad to think that he has not lived to enjoy the pleasure of seeing his results applied. Britain can ill afford the loss of men of Jay's type in the present sombre conditions.

H. LIPSON

WE regret to announce the following deaths:

Mr. C. W. Hobley, C.M.G., secretary during 1923–36 of the Society for the Preservation of the Fauna of the Empire, on March 31, aged seventy-nine.

Dr. Willard L. Valentine, editor of *Science* since January 1946, formerly professor of psychology in Northwestern University, on April 5, aged forty-two.

Henri Vallée, *Correspondant* for the Section of Rural Economy of the Paris Academy of Sciences, on March 12.

NEWS and VIEWS

Bacteriology and Immunology in the University of London: Prof. E. T. C. Spooner

DR. E. T. C. SPOONER, who has been appointed to the University of London chair of bacteriology and immunology tenable at the London School of Hygiene and Tropical Medicine, went to Epsom College and to Clare College, Cambridge, where he obtained first classes in both parts 1 and 2 of the Natural Sciences Tripos. After the completion of clinical study at St. Bartholomew's Hospital, he was house-physician to the late Sir Walter Langdon-Brown; he was elected to a Commonwealth fellowship and worked for two years with Prof. Hans Zinsser in the Department of Bacteriology of Harvard University. On his return from America he was elected to a fellowship at Clare College, and a University demonstratorship in the Department of Pathology at Cambridge. He was later elected to a University lectureship and took charge of the teaching in bacteriology for both Part 1 and Part 2 of the Natural Sciences Tripos.

On the outbreak of war in 1939, Spooner became a member of a group of workers at St. Bartholomew's Hospital, which had been 'evacuated' to St. Albans, who were engaged in the study and prevention of the spread of streptococcal infection in surgical wards. Afterwards Dr. Spooner was appointed by the Medical Research Council as the bacteriologist member of a group of medical men who were sent to the Middle East to report on the hospitals and laboratories in North Africa, Egypt and Palestine. On his return to England, Dr. Spooner was for a time in charge of the E.P.H.L.S. laboratory at Cambridge. At the end of the War, Dr. Spooner resumed his work as a University lecturer; in 1944 he was appointed senior tutor of Clare College. Dr. Spooner has published work on the spread of infective disease, especially streptococcal infection, and for his work in this field was awarded the Horton Smith Prize at Cambridge. His chief interest is in the filterable viruses and in virus-produced disease.

Awards of the Valdemar Poulsen Gold Medal

THE Valdemar Poulsen Gold Medal was instituted by the Academy of Technical Sciences in Copenhagen on the occasion of Valdemar Poulsen's seventieth birthday on November 23, 1939, and the first award was made on that date to Dr. Poulsen himself. Owing to the War, it was not possible to make further awards until 1946, when medals were awarded to Dr. E. F. W. Alexanderson and to Sir Robert Watson-Watt.

Dr. E. F. W. Alexanderson was awarded a Valdemar Poulsen Gold Medal for outstanding contributions to radio-technics, and particularly for the development of a radio-frequency alternator of high power and other system components important in the early progress of radio communication; Dr. Alexanderson was born in Sweden, but his whole work with radio-technics has been done in the United States, where he is a chief engineer of the General Electric Co. at Schenectady.

Sir Robert Watson-Watt was awarded a Valdemar Poulsen Gold Medal for outstanding contributions to the development of radio and particularly for his leading scientific part in the invention and development of the use of radiolocation.

New Chairmen of Research Boards

THE Lord President of the Council has made the following appointments to chairmanships of research boards of the Department of Scientific and Industrial Research from April 1, 1947: Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew, to be chairman of the Forest Products Research Board in succession to Prof. V. H. Blackman; Engineer Vice-Admiral Sir Harold Brown, recently senior supply officer, Ministry of Supply, formerly engineer-in-chief of the Fleet and, during the War, controller general of munitions production, to be chairman of the Fuel Research Board in succession to Sir Harold Hartley; Sir Stanley Angwin, chairman of Cable and Wireless, Ltd., formerly engineer-in-chief of the General Post Office, to be chairman of the Radio Research Board in succession to Lieut.-Colonel Sir George Lee.

A New Form of Camera

MR. EDWIN H. LAND, president and director of research of the Polaroid Corporation, demonstrated recently before the Optical Society of America a camera which produces a dry positive on paper 60 sec. after releasing the camera shutter. The camera contains a roll of film of conventional type, except that the support is opaque, and the exposure is made in the usual way. The camera also contains a roll of specially prepared paper which is not sensitive to light. The paper support is also opaque, and has attached, at intervals equal to the length of the picture, capsules containing a viscous solution of the processing materials. This solution includes hydroquinone and 'hypo' and is released when the capsule is burst on passage of the film and paper between pressure rollers. This takes place after exposure, and the solution is spread as a thin layer between the film and paper, where the following action is said to take place. The hydroquinone rapidly reduces the silver halide in the film in those regions where light action has taken place, thus immobilizing the silver in these regions. In the unexposed regions the 'hypo' takes the silver halide into solution, and diffusion and reduction take place, with the result that silver is deposited in the prepared surface of the paper, producing an image in silver. Since most silver is deposited in the paper in those regions where the least exposure occurs in the camera, the paper image is a positive. The film and paper are pulled apart when the action is complete, yielding a paper 'print' which has a slightly damp surface. The film-paper sandwich passes out of the camera immediately after passing the pressure rollers. The purpose of the opaque supports is to protect the film from further light action while the 'processing' is taking place. In some variants of the system further prints can be obtained from the 'negative', but in general it appears necessary to rephotograph the original to obtain further copies.

Historia Naturalis

IN September 1944, a small group of biologists met in Rome to consider means of promoting the interests of their science, and by December of the same year their suggestions had received sufficient support to justify the formation of a society of naturalists, Unione Italiana Naturalisti. By 1946, the society was strong enough to issue its own journal. This publication, *Historia Naturalis*, is about the same size as *Nature*, and each part so far published consists of 24 pages, exclusive of the cover. It is illustrated with line and half-tone text figures and is quite well printed. It appears three times a year—in March, June and September—and the issues of the first year are now to hand.

The object of the journal is not merely to record the meetings and activities of the society, which are many—indeed these only occupy a page or two—but to emphasize the fundamental unity of the biological sciences, interpreting these in a wide sense. It appeals not only to the professional specialist but also to the intelligent amateur. The major portion of each issue is therefore devoted to original studies and researches, to reports of conferences and symposia, to reviews and essay reviews covering diverse aspects of natural history. The original contributions have included, among others, general and vertebrate palæontology, geology (tectonics), evolutionary problems, animal populations and experiments on Coleoptera. We should like to congratulate our colleagues on their courage in making a start in this field when general conditions were far from encouraging, and welcome the new journal, which undoubtedly fills a need. If the publication fulfils the promise of its first year—and there is no apparent reason why it should not—it is assured of a permanent place in scientific literature. The annual subscription to *Historia Naturalis* is 150 lire, to be sent to Domenico Rossi, via Tomacelli, 132, Rome.

Engineering Degree Courses for Ex-Servicemen

MANY who were studying engineering before being called up for national service have been unable to complete degree courses, and although they have become competent engineers, their future career would benefit greatly if they were able to obtain a degree. Mr. O. S. Puckle, of R.F. Equipment Ltd., Langley Park, near Slough, Bucks, believes that suitable courses of study at a number of technical colleges throughout Great Britain, either in the form of a full day on Saturday or a half-day on Saturday and, say, one, or at most two, evenings per week, could be devised to meet this need. He therefore invites engineers or physicists who are interested in such a proposal to communicate with him. Should the number of replies prove to be sufficient, he proposes to communicate with the Ministry of Education in order to ascertain whether something can be done to meet the situation. He has in mind two types of course, covering two or three years and leading to final B.Sc. or B.Sc.(Eng.), depending on whether the intermediate examination has been passed. Replies, stating the nearest technical college which could be attended, should be sent to Mr. Puckle as early as possible.

World Power Conference on Fuel Economy

A PRELIMINARY programme has been issued of a sectional meeting of the World Power Conference to be held at The Hague during September 2–9, 1947, when the subject of discussion will be "Fuel Economy". The proceedings will be divided into three sections dealing with production, distribution and utilization respectively. Copies of national reports on fuel economy prepared at the request of the central office of the World Power Conference and also of all printed papers prepared for the meeting will be supplied to members of the Conference; all sessions will be devoted to oral discussion. Papers can only be submitted through national committees; the address of the British National Committee is 201–2 Grand Buildings, Trafalgar Square, London, W.C.2, to which intending members resident in Great Britain should apply for particulars. The address of the secretariat for the meeting is Vereeniging voor Congressen op Electrotechnisch en Aanverwant Gebied, 210 Utrechtscheweg, Arnhem, Netherlands.

X-Ray Analysis Conference

The 1947 Conference of the X-Ray Analysis Group of the Institute of Physics will be held at the Royal Institution, Albemarle Street, London, during April 22–23. The first day will be devoted to discussion of the training of X-ray crystallographers for science and for industry; the second will be devoted to new techniques and results. Mr. H. P. Rooksby, of the Research Laboratories, General Electric Co. Ltd., Wembley, will give an evening lecture on the technique of X-ray powder photography on April 22. Short papers only are being given, so as to leave time for informal discussions. The Conference is open to all interested in the subject. Further particulars can be obtained from the honorary secretary of the Group, Dr. F. A. Bannister, British Museum (Natural History), London, S.W.7.

Conference on Applications of Radioactive Tracer Elements

A CONFERENCE is being arranged by the Manchester and District Branch of the Institute of Physics on "Applications of Radioactive Tracer Elements in Physics Research and Industry" during July 10–12 in the Physics Department of the University of Manchester. The opening papers will be given by Dr. J. D. Cockcroft, Prof. F. Paneth and Mr. D. H. Wilkinson. The conference will be open to anyone interested, without charge, but admission will be by ticket only. Further particulars will be issued in due course by the Conference Secretary, W. J. Meredith, Christie Hospital and Holt Radium Institute, Wilmslow Road, Manchester 20.

University of Durham: Appointments

THE following appointments have been made in the University of Durham: Martin Jones, to be professor of agricultural botany at King's College, Newcastle; Ewen M'Ewen, to be professor of engineering in the Faculty of Agriculture at King's College, Newcastle; Alexander Kennedy, to be professor of psychological medicine at King's College, Newcastle; Leonard Slater, to be reader in geography in the Durham Colleges.

Arthur Stanley Eddington Memorial Lectureship

LAST year an appeal was launched to provide for the founding of an Arthur Stanley Eddington Memorial Lectureship to commemorate Eddington's life and work, by providing for lectures on some aspect of contemporary scientific thought considered in its bearing on the philosophy of religion, or on ethics, and to be delivered periodically in Cambridge, or elsewhere, and to be published. The Foundation Trust Deed has now been completed, and the following four trustees have been appointed: Prof. Sydney Chapman, representing the Royal Society; Prof. C. D. Broad, representing Trinity College, Cambridge; Dr. Kathleen Lonsdale and Dr. W. H. Thorpe, representing the Society of Friends. Mr. Howard Diamond, 45 St. Barnabas Road, Cambridge, is honorary treasurer and secretary of the trustees. The Fund is still open, and approximately £1,000 is now needed for its completion. It is hoped that the first lecture on the Foundation will take place towards the end of the present year.

The Boron-Trifluoride Catalysed Reaction of Di-isobutene

Dr. Alwyn G. Evans and M. A. Weinberger write: "In our recent communication on this subject [*Nature*, March 29, p. 437], it is stated that the addition of acetone vapour, purified by distillation *in vacuo* over freshly distilled sodium, to a non-reacting mixture of di-isobutene vapour and boron trifluoride initiates the fast reaction of di-isobutene. In our corrected proof of this letter [received too late for changes to be made. Editors] we deleted this statement on the grounds that since traces of water are so effective in initiating this reaction, we do not as yet wish to claim that completely pure acetone itself is effective in this way."

Announcements

THE James Watt International Medal for 1947 of the Institution of Mechanical Engineers will be presented to Prof. S. Timoshenko, recently professor of engineering at Stanford University, California, on April 25; he will speak on "Stress Concentration and Fatigue Failures".

MR. F. BRUNDRETT, of the Royal Naval Scientific Service, has been appointed chief of the Service in succession to Sir Charles Wright, who retires on April 30.

BY arrangement between the University of Sheffield and the Council of the Iron and Steel Institute, the second Hatfield Memorial Lecture will be given by Dr. C. Sykes, of the Brown–Firth Research Laboratories, Sheffield, in the Institution of Civil Engineers, London, on May 14 at 8.30 p.m., on the occasion of the annual general meeting of the Iron and Steel Institute, and will be entitled "Steels for Use at Elevated Temperatures".

DR. DOUGLAS GUTHRIE is delivering a course of lectures in the University of Edinburgh on the history of medicine, beginning on April 17. As part of the course, guest lectures will be given by Sir Arthur MacNalty on the evolution of preventive medicine in Britain on May 16, and by Sir Henry Bashford on Hans Sloane on May 23.

ERRATUM. In the communication "Spiral Cracks in Glass Tubes" by Dr. L. Norzi, published in *Nature* of March 1, p. 306, paragraph 5, line 2, for "$tg2\varphi = 2C|(B - A)|$" read "$tg2\varphi = 2C/|(B - A)|$".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Plasma Cellular Reaction and its Relation to the Formation of Antibodies *in vitro*

DURING secondary response, elicited in sensitized rabbits by means of intravenous injections of the homologous antigen, the number of plasma cells in the spleen increased considerably, simultaneously with the formation of antibodies[1]. The cellular reaction was localized almost exclusively to the red pulp, especially after the injection of living *Salmonella typhi* (about 500 millions/kgm.). The spleen was investigated by means of biopsies at intervals during antibody formation; differential counts of imprints were made and histological sections were examined. The stain used was methyl green pyronine (Unna–Pappenheim). In the earliest stages of the reaction, in the first phase of antibody formation, large reticulum cells of characteristic appearance (called transitional cells) presented themselves. One or two days later, immature plasma cells appeared at the places where transitional cells were previously found, and after a further few days mature plasma cells were seen in increasing numbers. There were numerous transitions between the different stages of development. No plasma cells were usually seen in the lymph follicles.

TABLE 1. COMPARISON BETWEEN THE CAPACITY OF THE RED AND THE WHITE PULP TO FORM ANTIBODIES *in vitro*. THE SPLENIC TISSUE EXAMINED AT DIFFERENT STAGES OF ANTIBODY FORMATION IN THE RABBIT

No.	Days after re-inject.	Serum titre		Duration of culture (hr.)	No. of plasma cells in each tube (1 cell about 0·2 mgm.)	No. of tubes containing 300 mgm. cult. fluid		Geom. mean of titres *in vitro*	
		Day of culture	Preceding day			Red pulp	Lymph follicles	Red pulp	Lymph follicles
S 167	4	1/10,240	1/1,280	12	1	12	12	1/12	0
	7	1/40,960	1/40,960	12	1	12	12	1/3·6	0
S 173	4	1/10,240	1/1,280	12	1	6	7	1/4·8	1/0·3
	7	1/81,920	1/81,920	12	1	7	7	1/3·6	1/0·4
S 186	4	1/5,120	1/640	8	1	10	10	1/4·6	1/0·3
				12	1	13	8	1/8·6	1/0·4
	10	81,920	81,920	12	1	6	6	1/2·8	0
S 175	4	1/640	1/160	8	1	10	10	1/3·7	1/0·8
				12	1	10	10	1/7·5	1/1·6
	8	1/10,240	1/10,240	12	1	11	10	1/0·5	1/0·1
S 190	4	1/1,280	1/80	5½	1	20	10	1/3·3	1/0·4
					2	10	8	1/5·5	1/1·3
S 203	5	1/20,480	1/2,560	8	1	27	20	1/19·7	1/1·4

TABLE 2. THE ANTIBODY FORMATION CAPACITY *in vitro* OF VARIOUS ORGANS RICH IN R.E.S.

No.	Duration of culture	Tissue in each tube (mgm.)	Geom. mean of titres of culture fluids				
			Splenic red pulp	Lymph gland	Thymus	Bone marrow	Liver
S 182	12 hours	0·4	1/30·0	0	0	0	0
No. of tubes			10	10	5	10	10
S 206	5 hours	0·8	1/72·7	L. axill. 1/2·7* L. popl. 0	0	1/1·0	1/1·0
No. of tubes			12	6 each	12	12	12

* Lymph. gland. axill., regional to the subcutaneous agar focus containing antigen, through which the rabbit was sensitized.

Antibody formation in vitro. Small pieces of spleen tissue, partly from the red pulp, partly from the lymph follicles, were excised in different phases of antibody formation, and their capacity for forming antibodies *in vitro* was investigated. In each tube, containing 300 mgm. of fluid, one or two pieces were cultured. Their weight (wet) was about 0·2 mgm. The culture fluid consisted of normal rabbit serum (3 parts), tyrode solution (2 parts) and isotonic sodium bicarbonate (1 part). A gas mixture, consisting of 80 per cent oxygen, 4·5 per cent carbon dioxide and the remainder nitrogen, was passed into the tubes[2]. The tubes were incubated at 37° for 5–12 hours. The capacity for antibody formation *in vitro* of the red pulp rich in plasma cells proved to be considerably superior to that of the lymph follicles (see Table 1). By serial investigations on the same animal, it was found that the tissue pieces were most active in forming antibodies when the immature plasma cells predominated. The transition from immature to mature cell coincided with a decline in the capacity to form antibodies *in vitro*. Pieces of the same size were excised from other organs rich in R.E.S. Their capacity for antibody formation *in vitro* was investigated and proved to be very much inferior to that of the red pulp of the spleen (see Table 2). Experiments were also made to trace the antigen (living *Salm. typhi*) after intravenous injection. The greatest number of bacteria was found in spleen and liver, less in bone-marrow, and very few bacteria could be demonstrated in lymph glands and thymus. In the spleen the bacteria were found in large numbers in the red pulp, and only small numbers in the follicles.

It is concluded that plasma cells appear in connexion with great antigen stimulation. The antigen incites a conversion and an intensification of the protein production in the reticulo-endothelial cell. From the functional point of view, development culminates in the formation of the immature plasma cell. The further differentiation of the cell, when mature plasma cells appear, marks the transition to a less active state, and the mature plasma cell then becomes the final link in a chain of development, a cell which has already passed its greatest functional activity.

ASTRID FAGRAEUS
Statens Bakteriologiska Laboratorium,
Stockholm 1.
Feb. 1.

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[1] Fagraeus, *Nord. Med.*, 30, 1381 (1946).

[2] Cf. Parker, "Methods of Tis ue Culture" (New York, 1938).

Phenyl-thio-carbonyl Chloride as a Group-protecting Agent

THE use of the carbobenzoxy reagent for protection of amino-groups in the course of peptide synthesis has, in spite of its obvious advantages, some limitations. In some cases, hydrogenolysis of the benzyl group is complicated by simultaneous hydrogenation of other groups present, and also carbobenzoxy compounds are sometimes difficult to crystallize; for example, *N*-carbobenzoxy-glycyl-cysteine ethyl ester. The use of another protecting unit easily removed by hydrolysis in combination with the carbobenzoxy method would considerably extend the use of the latter.

Phenyl-thio-carbonyl chloride, $C_6H_5S-COCl$, as prepared by Rivier[1], would appear to be of use in this respect. The corresponding amide and phenylamide were reported by Rivier to be stable in dilute acids and easily hydrolysed by alkalis. The extension of the method to other amides and to the amino-acid series has now been developed. Direct Schotten–Baumann acylation in aqueous alkali solution was not very successful, but the reaction of one mole of phenyl-thio-carbonyl chloride with 2 moles of amino-acid ester in ether or ethyl acetate proceeds easily at room temperature, one mole of amino-acid ester hydrochloride being liberated. After washing with dilute hydrochloric acid, the phenyl-thio-carbonyl amino-acid esters are easily isolated. Among the compounds prepared are phenyl-thio-carbonyl-glycine ethyl ester, m.p. 104°, and bis-(phenyl-thio-carbonyl)-cystine dimethyl ester, m.p. 108°.

The acylamino-acid esters thus prepared are easily de-esterified by heating for ten minutes in a mixture of concentrated hydrochloric acid and glacial acetic acid (1 : 1), the phenyl-thio-carbonyl group being remarkably stable in acids. The free acylamino-acids separate on dilution with 2 moles of water (for example, phenyl-thio-carbonyl-glycine, m.p. 155°), and can be converted to the corresponding chlorides by the action of phosphorus pentachloride in ether. The chlorides (for example, phenyl-thio-carbonyl-glycine chloride, m.p. 87°) crystallize readily and are rather stable. They react in ether or chloroform solution with free amino-acid esters to form peptide esters: phenyl-thio-carbonyl-glycine-glycine ethyl ester, m.p. 127°, phenyl-thio-carbonyl-glycine-*dl*-alanine methyl ester, m.p. 116°, phenyl-thio-carbonyl-glycine cysteine ethyl ester, m.p. 114°. The latter crystallizes readily, unlike the corresponding carbobenzoxy compound. In general, the melting points of the phenyl-thio-carbonyl derivatives lie about 50° above those of the carbobenzoxy compound.

The removal of the phenyl-thio-carbonyl-group is easily carried out by heating for five minutes with a solution of lead acetate in 70 per cent ethanol or by treating in the cold with 0·1 *N* alkali in the presence of lead hydroxide or lead carbonate, yellow lead phenylmercaptide being precipitated. In alkali, phenyl-thio-carbonyl-amino-acids are decomposed in 10–30 sec., the corresponding esters reacting similarly in 5–10 min.

This observation, together with the fact that PhS—CO—O— and PhS—CO—S compounds could be similarly prepared and split, provides a basis for an extension of peptide synthesis. Compounds of the type PhS—CO—O*R* can be prepared by heating the appropriate alcohol with phenyl-thio-carbonyl chloride either alone or with alkali (10 per cent). The alcohol can also be employed in the form of alkoxide. Phenols and SH-compounds react in the same way. The use of phenyl-thio-carbonyl chloride is capable of a number of variations and should find useful applications in other fields.

Full details of this work in connexion with peptide synthesis will be published elsewhere.

G. C. H. EHRENSVÄRD

Wenner-Grens Institute,
University of Stockholm.

Feb. 15.

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[1] Rivier, *Bull. Soc. Chim.*, (4), **1**, 733 (1907).

Use of Seeds in the Insect Transmission of Some Plant Viruses

THE methods previously adopted for the insect transmission of the viruses causing swollen-shoot disease of cacao (*Theobroma cacao* L.) employed seedlings usually between six and twelve months old. An improved technique utilizes the seed as a test plant and a watch-glass or specimen tube as a cage, a method which might be applicable to experiments with viruses of other plants with exalbuminous seeds.

The cacao bean is taken from the ripe pod, the testa removed, and one cotyledon dissected away to expose the convoluted surface of the other. Insects which have fed on an infected plant for the required time are transferred with a brush to the bean, placed in a solid or 'block' watch-glass. Humidity can be maintained by a square of damp filter paper under the cover of the watch-glass, and after the desired feeding time, the insects are killed with nicotine solution. The beans are then planted in sterilized sand in an insect-proof house. Germination is not affected, and symptoms usually appear in the first or second pair of foliage leaves, occasionally in the third. The vectors used successfully in these experiments are the mealy-bugs, *Pseudococcus citri* Risso, *Ps. njalensis* Laing, and *Ferrisia virgata* Ckll., which feed readily on the beans not only of cacao but also of *Cola* spp., and of *Phaseolus vulgaris*.

The use of beans in small containers has numerous advantages over that of larger plants in pots. The movement of the vectors is controlled, and feeding periods can be observed conveniently with a microscope. Complete exclusion of other insects is ensured without the necessity for cages, and a large number of test plants can be accommodated in a small space in the laboratory. Unless the virus under investigation is seed-transmitted, when care would be taken to ensure an uninfected source of seed, any chance of prior infection of the test plants is eliminated, together with the difficulty of maintaining a constant source of virus-free plants of the correct size and condition for vector experiments. Not the least important advantage of the method as applied to cacao is a shortening of the mean period between the time of infection and of the development of symptoms, and a reduction in its variation between plants. In experiments using large plants, the interval between inoculation and the appearance of symptoms depends on the periodicity of growth-flushes, which differs greatly with season and also between plants, resulting in latent periods varying between three weeks and four months. When seed is used, symptoms are usually visible in the leaves about three weeks after the beans were infested.

The method can be modified for testing suspected vectors found in natural outbreaks of virus diseases far distant from the laboratory. Peeled cacao beans are planted in damp sterilized sand in specimen tubes of suitable size, with the mouth sealed with muslin held by a rubber band. Germination commences at once, and a seedling can be kept in each tube for about two weeks prior to transplanting. Suspected vectors found on infected plants are transferred to the cotyledons and allowed to feed until the return to the laboratory, where they are removed and the seedling planted. In this way virus transmissions were carried out in outbreaks of swollen-shoot disease in the Ivory Coast, and the infected plants established in the Gold Coast after a tour of 1,400 miles lasting seventeen days.

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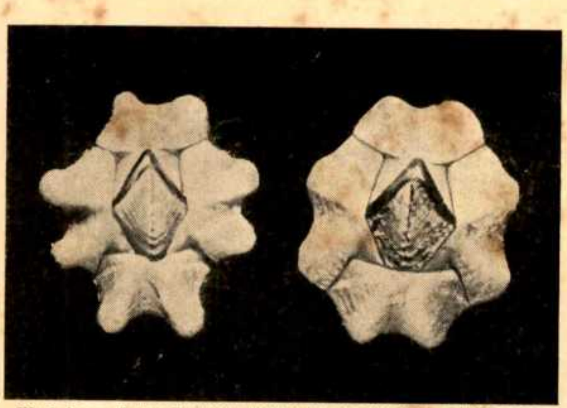
Establishment of an Immigrant Barnacle in British Coastal Waters

As part of the programme of anti-fouling investigations being carried out by the Marine Corrosion Sub-Committee of the British Iron and Steel Research Association, data have been collected on the nature of fouling organisms and their seasonal variations of settlement and growth at a number of stations around the British coasts. A full account of this work and of work on the fouling of ship bottoms will be published at a later date, but it seems desirable to record the establishment in British waters of an austral barnacle, which appears to have arrived as a component of ship-fouling.

The examination of small, unpainted 'Bakelite' panels immersed for successive monthly periods at constant depths of 2 ft. and 4 ft. from the Admiralty Raft inside the mouth of Chichester Harbour, West Sussex, has shown that heavy settlements of acorn barnacles characterize the fouling settling at this site from mid-March to the end of October. These barnacles have been identified as *Elminius modestus* Darwin, a common estuarine barnacle in southern Australia and New Zealand, and *Balanus improvisus* Darwin, a common estuarine form in British and northern temperate waters. The settlement density and relative numbers of the two species have varied from month to month, but in general the former species has been the more abundant. In July 1945 the average numbers were two hundred *E. modestus* and two *B. improvisus* per square inch of surface area. The alien species has grown well (attaining a carino-rostral diameter of 6 mm. in 40 days during June and July), but less rapidly than *B. improvisus*, which furthermore appears to be a larger species when fully grown.

Darwin[1] gives the distribution of the genus *Elminius* as "southern temperate seas", and of the species *E. modestus* as "New South Wales, Van Diemen's Land, New Zealand"; and Gruvel's brief reference[2] to a new species, *E. cristallinus*, from the Azores appears to be the only published report of the occurrence of the genus in the northern hemisphere. Moore[3], in a recent account of *E. modestus*, describes it as a common estuarine, inter- and sub-tidal form in New Zealand, averaging 5 mm. in diameter, breeding throughout the year and occurring as fouling on harbour vessels and test panels. This species in its native waters appears to occupy the position held by *B. improvisus* in the British fauna. Its appearance is superficially not unlike that of the common British shore barnacles, but a close examination shows that the compartments are reduced to four in number (see photograph) in contrast to six present in the genus *Balanus*.



Elminius modestus DARWIN, TAKEN FROM CHICHESTER HARBOUR, SHOWING THE ARRANGEMENT OF THE FOUR COMPARTMENTS. NATURAL SIZE, 6 MM. CARINO-ROSTRAL DIAMETER

I have been unable to examine the shore of Chichester Harbour for the alien species, but the foregoing data clearly show that *E. modestus* is well established at this site. Two further records of the species, in both cases associated with *B. improvisus*, suggest that this immigrant is also present in other localities on the coast. The species was taken from the hull of the S.S. *Queen Elizabeth* (August 1946) after a long stay at Southampton subsequent to North Atlantic service, and from the hull of the M.V. *Empire Wansbeck* (October 1946), which had been plying between Harwich and the Hook of Holland.

Observations on ship-fouling show that a variety of foreign marine organisms, often fully grown and living, are continually being brought into British waters on ship hulls, and that many of these species are able to survive for long periods while the vessels are in British ports. There is little evidence, however, that alien species have been introduced to the coasts of Great Britain in this way, and probably the low water temperature prevents breeding in most of these species (Orton[4]), a consideration which would not apply to warmer seas. It is of interest to note in this connexion that in 1937 Mr. D. Dilwyn John (personal communication) collected a species of foreign barnacle, probably a variety of *B. amphitrite*, from buoys in the Shoreham Harbour Canal, the water of which was heated to approximately 10° F. higher than the outside channel water (in November of that year) by large discharges of hot sea water.

It seems likely that *E. modestus* has been carried from its native coasts to the south coast of Britain as fouling on a ship, and being a temperate water species, has been able to establish itself. This theory is supported by the occurrence in October 1946 of this species on the hull of the M.V. *Waipawa* at Liverpool, after service in southern Australia and New Zealand. These specimens of *E. modestus*, associated with *B. amphitrite* Darwin and *B. trigonus* Darwin, were living, in good condition, and fully grown (9 mm. carino-rostral diameter), but the gonads were in a very early stage of development. All three species had successfully survived a fast passage at 17 knots for 30 days, via the freshwater lakes of the Panama Canal.

I am grateful to Dr. J. P. Harding, British Museum (Natural History), for confirming the identity of

E. modestus, to Dr. H. G. Stubbings (Admiralty) for supervising the exposure of panels in Chichester Harbour, to the Cunard White Star Line, Ellerman's Wilson Line and Shaw Savill and Albion Line for their assistance, and the Marine Corrosion Sub-Committee for permission to publish this communication.

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British Folliculinidæ (Ciliata, Heterotricha)

While examining plates submerged in sea water at Cullercoats, I have come across two species of Folliculinidæ which, to my knowledge, have not been reported so far from Great Britain. They are *Folliculinopsis* (*Folliculina*) *producta* Wright and *Folliculina simplex* Dons. The *Folliculinopsis producta* forms are remarkable for their large size and extreme elongation of the body, the overall length of my specimens ranging from 2,000 μ to 2,600 μ (2·0–2·6 mm.); and a few specimens were as long as 3 mm., a large size indeed for a simple non-colonial protozoon. The biology of these two species has been worked out and is being published elsewhere.

Sixteen well-marked species of Folliculinids are known from the Continent[1,2] and ten species from the United States[3], while only three species have been recorded from Great Britain so far[4,5,6], namely, *Folliculina ampulla* Müller (Plymouth and Port Erin), *Folliculina elegans* Clap. and Lach. (Port Erin), and *Parafolliculina hirundo* Kent (Channel Islands). The present two species from Cullercoats bring the number of British Folliculinidæ to five.

My thanks are due to Prof. A. D. Hobson for helpful suggestions and to Dr. H. O. Bull for assistance in identification.

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Entamœba sp. from the Syrian Hamster (*Cricetus auratus*)

During the course of work on experimental infections of *Entamœba histolytica* in rats, it was noticed that rats sometimes developed spontaneous infections with an amœba showing characters differing from those of *E. histolytica*. An examination of hamsters, which were housed in the same room, revealed the presence of a similar amœba. Hitherto there has been no report of an amœba parasitic in the hamster.

All observations were made on fresh material, an also on fixed and stained smears made from hamste used for tests of leishmanicidal drugs.

Amœbic infection was found in fifty hamste (59 per cent) of eighty-five examined; of these, thirt seven harboured only the trophic amœbæ, whi thirteen also had cysts. Pseudopodia consisted ectoplasm, clearly demarcated from the endoplas and in stained specimens presented a homogeneo structure. In a fresh smear the rounded forms ha a diameter of 17–28 μ. The spherical nucleus varie in size between 3·50 and 5·75 μ; it contained a co pact, rather irregularly shaped karyosome whic occupied a very eccentric position, being frequent situated near the nuclear membrane. The periphe chromatin consisted of a layer of fine granules mo or less in contact with one another. The endoplas was vacuolated; food vacuoles contained bacteri plant debris, and other Protozoa, chiefly trichomonad *Sphœrita* was also present in some cases.

The ripe cysts contained eight nuclei, the kary somes of which were usually strongly eccentri Chromatoid bodies, not commonly present, wer elongated with irregular ends. The cysts ranged i size from 12·5 to 22 μ in diameter, with an averag size of 17 μ. No evidence of races of larger or smalle dimensions has yet been obtained.

Experiments were performed to determine whethe the amœbæ from the hamster were infective to rat Suspensions of cæcal contents of infected hamste were administered orally to young rats each receivin 0·25 ml., containing eighteen cysts. The rats wer isolated in cages, special precautions being taken t prevent accidental contamination, and the cæc examined after ten days. Nine of eleven inoculate animals developed amœbic infections, while norma control animals kept under identical conditions a remained free from infection.

The amœbæ from the hamster thus proved to b infective to rats. The morphology of the trophi amœbæ and cysts was unaltered in the second host The amœbæ were found to survive for a time i Dobell and Laidlaw's horse-serum and Ringer eg medium[1], but did not multiply and died after twent four hours.

The amœba was apparently non-pathogeni although two of the experimentally infected rat showed slight diarrhœa. From these observation it would seem that the rats might acquire thei infection from hamsters kept in the laboratory.

Fuller details of this investigation will be publishe elsewhere.

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Isotropy in the *J* Striation of Striated Muscl

Frey-Wyssling[1], following Hürthle, explains th isotropy of the *J* striation in muscle as the crossin of micellar structure. C. E. Hall, M. A. Jakus an F. O. Schmitt[2] established by electron micrograph that myofibrils are composed of parallel bundles filaments lying axial with the fibrils both in the and *J* striations. On the basis of their experiment these authors put forward two hypotheses to explai the isotropy: it is caused either by differences in orientation within the filaments in the J striation, or by a component which compensates the positive birefringence of the filaments.

We have carried out investigations on rat muscle. Muscle pieces 1 cm. long and of 2–3 mm. diameter were treated for 20 minutes at 0° with a solution containing 0·6 mol. potassium chloride + 0·04 mol. sodium bicarbonate + 0·01 mol. sodium carbonate + 1·0 per mol. adenosintriphosphate. After this they were treated for another 20 min. with 0·6 mol. potassium iodide solution. In this way the contractile substances (myosin and actin) were extracted[3,4]. Then the pieces of muscle were put into solutions of potassium iodide of successively decreasing concentrations until, by swelling, the muscle pieces regained their original size.

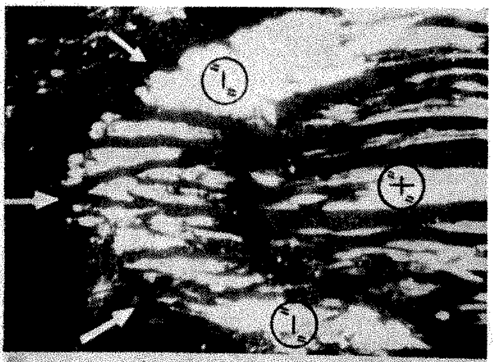

Fig. 1

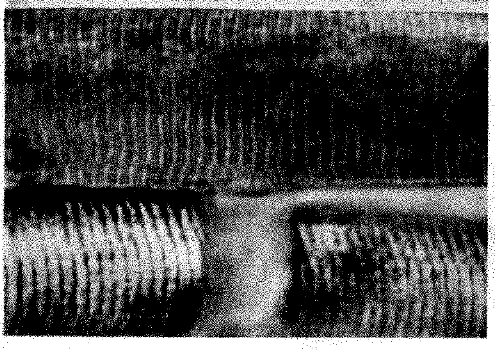

Fig. 2

Fig. 1. A BUNDLE OF MUSCLE FIBRES TREATED WITH WEBER'S SOLUTION AND WITH 0·6 MOL. POTASSIUM IODIDE. THE ARROWS SHOW THE DIRECTION OF PENETRATING SOLUTIONS. PHOTOGRAPHED IN POLARIZED LIGHT USING A GYPSUM PLATE (RED I.) AT + 45°. THE FIBRES MARKED "+" ARE INTACT SHOWING POSITIVE DOUBLE REFRACTION; THE MARGINAL FIBRES MARKED "|" HAVE A NEGATIVE DOUBLE REFRACTION

Fig. 2. (*a*) AN UNTREATED MUSCLE FIBRE IN POLARIZED LIGHT USING GYPSUM PLATE (RED I.) AT + 45°. THE Q STRIATION AND THE Z LINE ARE BLUE (LIGHT IN PHOTOGRAPH); THE J STRIATION IS DARK

(*b*) A MUSCLE FIBRE TREATED WITH WEBER'S SOLUTION + POTASSIUM IODIDE (SIMILAR ADJUSTMENT). THE J STRIATION IS YELLOW-COLOURED (LIGHT IN PHOTOGRAPH); Q STRIATION AND Z LINE ARE DARK

The treated muscle pieces were fixed in 10 per cent formaldehyde and embedded in paraffin. We cut the sections at 10 μ and analysed them by a polarized-light microscope, using a gypsum plate (Red I. + 45°). It was found that the areas penetrated by the solution became negatively birefringent (Fig. 1). With greater enlargement it was noticed that the negative birefringence appears in the J striation, and that positive birefringence disappears, so that the Q striation becomes dark (Fig. 2). Quantitative measurements gave the negative birefringence of the treated fibres as $n_\gamma - n_\alpha = -39 \times 10^{-4}$, of the untreated fibres as $n_\gamma - n_\alpha = +40 \times 10^{-4}$.

The negative birefringent material was called N-material. It is extractable from the J striation with Weber's solution containing 30 per cent urea. The extracted substance showed a strong double refraction of flow. In our control experiments it was established that the N-material is originally in the isotropic striation and is not a product of the action of potassium iodide on muscle proteins. It is evident that the N-material locally compensates the positive birefringence of the contractile-proteins and is the cause of isotropy.

We found the N-material to be identical with the negative doubly refracting and phosphorus-containing structure-protein isolated by I. Banga and A. Szent-Györgyi[5]. It is probably the substance seen in the electron micrographs of muscle fibril made by Hall, Jakus and Schmitt and marked "N stripe".

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Tumour Inhibition with Extracts of Urine

FROM time to time, various investigators have reported upon growth-inhibiting and growth-stimulating properties of extracts of urine[1]. The investigations outlined below are being conducted in relation to the extract known as H.11, and it is with the former of these that we are concerned, although we have noted the presence of the latter.

In our experimental investigations, which are directed towards the isolation of compounds with tumour-inhibiting properties, as a preliminary means of recording whether or not an extract is active—and by this is meant its ability or otherwise to produce inhibition or, more desirably, complete permanent regression of tumour growth, without causing measurable toxic condition in the animal under treatment—we have used the Twort alveolar carcinoma.

From a considerable number of fractions tested for tumour-inhibiting properties, we have found that normal male urine, acidified to pH 4 and continuously cold-extracted with toluene, results in a crude extract containing the active agent. A considerable quantity of inactive material, chiefly in the way of pigments, is removed with activated carbon. Absorption of the resulting extract upon activated alumina, and subsequent elution with toluene + 1 per cent ethanol, results in a considerably purified active extract. Of some twenty fractions obtained from the chromatographic analysis, this is the only fraction which has consistently shown the power to inhibit the growth of the Twort alveolar carcinoma. This fraction is partitioned against 60 per cent ethanol, and the active principle is found to be contained in the aqueous alcoholic phase. The dissolved solids contained in this phase are converted into an aqueous colloidal extract, buffered to pH 7, and this extract is at present used for bio-assay.

It is impossible at this stage to give any indication as to the possible chemical nature of the active agent contained in the extract at present employed for bio-assay. The extract is subject to oxidation fairly readily; it exhibits neither œstrogenic nor androgenic activity in either bio-assay or by chemical colorimetric determinations. These facts are supported by adsorption spectra data. Aqueous extracts appear to lose activity after about a month's storage in a refrigerator; stability to heat has been established to 100° C. at 20 mm. pressure in the absence of water. Decomposition occurs at about 60° C. when heated at atmospheric pressure in the presence of water.

Hot hydrolysis of urine under the conditions usually employed for the isolation of sex hormones, and subsequent treatment by the method outlined above, results in an inactive material. Attempts at chemical separation, such as benzoylation, acetylation, half succinate division into alcoholic and non-alcoholic material, Girard division into ketonic and non-ketonic fractions, and the orthodox procedures employed for the separation into acids, bases, phenols (strong and weak) and neutral compounds, have failed to give significant biological results.

Bio-assay has been carried out on a large number of mice, and present indications are that response to treatment is maximal in daily doses of $400\,\gamma$, as measured in terms of total solids. Toxicity tests have been carried out on all fractions prior to bio-assay. Injections were carried out over a period of ten days, response to treatment usually commencing at about the fourth day. The route employed was by intraperitoneal injection, and it has been noted that tumour size does not materially affect the issue, as an extract capable of inhibiting the growth of small tumours has been found equally capable of inhibiting the growth of tumours of larger area and vice versa.

Of a total number of sixty-eight tumour-bearing mice, 33·6 per cent showed varying degrees of inhibition of tumour growth; 36·8 per cent showed partial regressions of tumours; 23·5 per cent showed complete regressions of tumours, and 7·1 per cent showed no response at all; the number of controls being forty-six, and having 4·4 per cent spontaneous regressions.

The fraction employed at this stage of the research has since been further separated into eight fractions, and these are at present under biological and chemical investigations.

We are indebted to Mr. J. H. Thompson, director of research at these Laboratories, for his constant help and encouragement during the course of these investigations, to Dr. O. Pecznick, of the Department of Pathology, for undertaking the bio-assay of the numerous fractions we have produced for examination, and to all other members of the research staff for their continuous interest and helpful discussion.

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A Possible Explanation of the Relation between Hereditary Anæmias and Depigmentation in the Mouse

IN mice there are two chief forms of hereditar anæmias, the macrocytic and the siderocytic c flexed tail anæmia[1]. The former is due to one of th dominants W or W^v, the first of which is lethal whe homozygous while the second is viable. WW an W^vW^v animals are white with black eyes, and in th heterozygotes with the normal w the two factors ma or may not show dominance, according to the facto concerned and the genetic background[2]. The othe form of anæmia, the siderocytic, is due to the recessiv factor f and is also associated with depigmentatio All the ff animals show a transitory anæmia at birt and the majority of them have also a white spot o the belly and many times also a flexed tail.

The relations between macrocytic anæmia an total depigmentation on one hand, and siderocyti anæmia and belly spot and flexed tail on the othe have remained obscure and constitute one of the mos puzzling cases of pleiotropic action of genes[3,4]. I has been suggested that in siderocytic anæmia th primary effect might be the anæmia, the other being secondarily induced by a diminished oxyge transport to the tissues[5]. It is also stated, howeve that "there is no foundation in observed facts for th assumption that variegation of the fur is physiologically conditioned by an anæmia"[5].

Nevertheless, it is known that some factors ar common to both hæmoglobin formation and melani production. Among these the factors belonging to th group B vitamins[6] and copper[7] are outstanding. A hepatic extracts have not cured mice with macrocyti anæmias[1] and the action of these extracts is generally associated with group B factors, it seems mor likely that copper is the link between the two kinds o anæmias and pigmentation. In addition to the fac that copper is necessary for normal hæmoglobin production, it must also be remembered: (1) that coppe is the co-ferment (or at least part of the co-ferment of tyrosinase and polyphenoloxidases in general (2) that one of the primary steps in the formatio of melanins is, very probably, the oxidation of compounds with phenolic OH groups by tyrosinase o other phenolases; and (3) that the liver, importan as an embryonal hæmatopoietic organ, and the hai are relatively very rich in copper.

In spotted areas the cells of the hair matrices do no possess the Golgi structures (also called lipochondrie found in pigment-producing hairs[8]. Possibly th could be fixed early in embryonic life by the migratio or non-migration of certain neural crest cells to th affected areas of the epidermis[9]. 15-day old mic embryos already show differentiation of their epidermis so far as concerns the hair follicles, as has bee proved by cultures on chick allantois[10]. Only thos agents acting prior to this time will be expected, therefore, to have an effect upon the production of localize or generalized white spotting. Macrocytic anæmia i known to be plainly manifest at the sixteent embryonic day, and must have appeared several day before. Siderocytic anæmia is apparent at the thirteenth day of embryonic life, while the tail cartilag differentiates partially into fibres at the fourteent to fifteenth day[1]. It seems very probable that th most severe, the macrocytic anæmia, will be found t appear by the twelfth day, when the primitive bloo cells are replaced by intermediate (in the sense use by Grüneberg) and definitive erythrocytes.

As yet we have no data on the exact time of determination of the melanophores in hair follicles, or, which in the end is the same, on the time of differentiation of the Golgi structures characteristic of hair matrices capable of forming melanins. From what has been said above, it is reasonable to expect, however, that this differentiation (after migration, perhaps) will take place by the time that factors W, W^v and f exert their action. If so, a deficiency in a copper compound, necessary both to hæmoglobin production and to the synthesis of phenolase, will have the effect of causing anæmia and a lack of pigmentogenesis in the hair matrices now in differentiation. The difference between the actions of W, W^v and of f probably depends upon the time of action and the intensity of the two kinds of factors, the first acting more early and hindering, therefore, all differentiation of melanoblasts (in heterozygotes sometimes only partially), while by the time f comes into action only the melanophores of the median belly line would be yet undifferentiated. The flexed tail of the ff mice probably is a secondary effect due to the anæmia being at its peak exactly when the fibrous tail structures are differentiating. This seems more probable when it is considered that in mice several factors affect the tail as secondary effects.

The copper compounds upon which the primary action of W, W^v and of f is exerted will be perhaps related in the two cases. As the steps in the synthesis of copper proteins are not known, we must suppose that the compounds involved in the two anæmias and in depigmentation will be perhaps intermediates between ionic copper and cupro-proteins. The primary action of W, W^v and f would be a hindering, more transitory in f, of the synthesis of these compounds.

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Relation of the Thyroid to Infections

Izzo and Cicardo[1] have reported an inhibiting effect of thyroxine on experimental tuberculosis in guinea pigs. The experiments were suggested by the chemical resemblance of thyroxine to diploicin, which exerts a bacteriostatic action on *Mycobact. tuber.* But the authors envisaged also the possibility of an unspecifically stimulating effect of the thyroid as an explanation of their experimental results. I should like to direct attention to some earlier observations on the influence of the thyroid on infections in general and particularly on tuberculosis.

Kallos[2] reported on human cases of hypothyroidism suffering from severe pulmonary tuberculosis which exhibited a lowered sensitivity to tuberculin. Treatment with thyroid extract improved the condition and raised at the same time the tuberculin sensitivity. Later, Kallos and Müller[3] found that percutaneous tuberculin tests in general are liable to be intensified by the administration of thyroxine. Bettini[4] observed favourable effects of treatment with thyroid extract on laryngeal tuberculosis.

The observations of Kallos and Müller suggest rather a systemic stimulation of the defence mechanisms than a specific bacteriostatic action. An unspecific stimulation in infectious diseases was attributed to the thyroid in 1929 by Guillaume[5]. Lauber[6] achieved an increased resistance against acute infections by administration of thyroid extract, and Weichardt[7] an inhibition of growth of transplanted tumours. In typhoid patients, Reitler[8] observed a marked rise (two- to fourfold) of the O- and H-agglutinin titre after three days administration of small doses of thyroid extract (twice daily 0·025 gm.), while controls in the same stages of disease showed no titre change after so short a time. Larger and smaller doses had a less marked effect. Such an optimum has been described already by Thaddea[9] in respect of the increased erythro- and leucopœsis caused by thyroxine.

An unspecific factor is, therefore, certainly involved in the effect of thyroxine on the course of infections. As Weichardt thought, it is probably due to the increase in cellular metabolism (personal communication). But it may be that in the particular case of tuberculosis this unspecific stimulation combines with an antibiotic action on the causative organism.

R. REITLER

Government Laboratory,
Haifa. Jan. 24.

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Chromosome Numbers in Cancer Cells

DURING an investigation on the variation of the chromosome system in human cancer of the uterus, we were able to observe frequently (in six epitheliomas of the uterus portio) a mitotic figure with a peculiar aspect of the chromosomes. In such cell divisions (which appear mixed with normal, heteroploid and polyploid ones) 24 chromosomes are present. Their shape resembles the meiotic one, being strongly contracted. The prophase shows thick threads, as in the pachytene stage, and later the synaptic males appear unsplit. No chiasmata are to be seen; the metaphase shows that every element is double.

It seems likely that the result of these divisions may be a reduction of the chromosome number. The cells in which the phenomenon appears are those termed *A* by Caspersson and Santesson[1].

This finding may be connected with the observation in 1906 of Farmer, Moore and Walker[2], and with that by Evans and Swezy[3]. But while the former is generally held to be doubtful, the latter concerns tetraploid cells, where the reduction to haploidy is impossible with a single mitosis. Haploid cells, on the other hand, were actually observed by Koller[4]. Finally, meiosis-like figures were found by Hearne Creech[5] in cultivated mouse fibroblasts previously treated with carcinogenic substances.

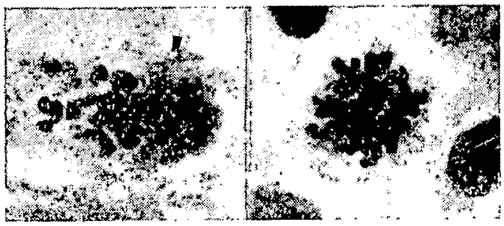

Fig. 1 Fig. 2

Fig. 1. METAPHASE PLATE IN A CANCER CELL, WITH 24 PAIRED CHROMOSOMES. SMEAR STAINED WITH ACETOCARMIN. × c. 1,000

Fig. 2. NORMAL METAPHASE PLATE WITH 48 CHROMOSOMES. NOTE THE SIZE AND DIFFERENCES OF SHAPE COMPARED WITH THE CHROMOSOMES OF FIG. 1. SMEAR STAINED WITH IRON HÆMATOXYLIN. × c. 1,000

If the pairing chromosomes are unsplit in the early prophase, the phenomenon might be compared with the early leptotene according to Darlington, and the nuclear precocity might be explained as the result of the general upset of the nucleic acid cycle in the malignant cell already pointed out by Caspersson and Santesson[1].

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Feb. 14.

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Chemical Composition of Egyptian Cow's Milk in Relation to Milk Laws

AN investigation of the composition of cow's milk in Egypt has been undertaken through seven lactation seasons, from 1937 to 1944, involving 2,817 samples. The cows were those forming the herd of the Faculty of Agriculture; most of them were born and reared in the farm of the Faculty, and the rest were bought from lower Egypt. A wide variation in constituents has been shown, and this is due to the lack of particular breed and to the seasonal variations. The accompanying table shows the total average of milk constituents, their maximum and minimum, and the extent of increase and decrease above and below the average:

	Density	Fat %	Solids (not fat) %	Total solids %	Water %	Fat / T. solids %
Average	1·0315	4·87	9·11	13·98	86·02	34·72
Maximum	1·0375	9·25	10·57	18·73	89·76	50·80
Increase %	19·05	89·94	38·53	33·98	4·35	46·31
Minimum	1·0230	2·00	7·06	10·24	81·27	15·03
Decrease %	26·98	58·93	22·50	26·75	5·52	56·71

Owing to the great variations in the composition of milk it seems difficult to prove that a milk sample is adulterated by either adding water or separating cream. It is due to these wide individual variations that a genuine sample with a very low amount of fat can be considered legally adulterated according to the present milk regulations in Egypt. The present limits for cow's milk in Egyptian milk laws[1] are the same as those applied in Scotland, and all the conditions are quite variable. These laws state that if fat and solids-not-fat are less than 3 per cent and 8·5 per cent respectively, the sample is suspected of being adulterated. In Scotland, Tocher[2] found these figures after a study of 676 milk samples, in which case the average fat was found to be 3·95 per cent and average solids-not-fat was 8·78 per cent. He further found that fat of 56 samples (8·38 per cent of animals) was less than 3 per cent, and this is the least limiting figure to determine whether a sample was genuine or not. 167 samples (24·70 per cent of animals) also had solids-not-fat less than his average figure 8·5 per cent.

Our data show that the average fat content in the 2,817 samples was found to be 4·87 per cent. Out of this number of samples only 26, or 0·92 per cent, of the whole samples gave fat figure less than 3 per cent. The same happened in solids-not-fat, where the average figure was 9·11 per cent, and only 625 samples (22·15 per cent) showed less than 8·8 per cent. The lowest limiting figures of Tocher could therefore not be applied to Egyptian cow's milk. If the number of animals was taken into consideration, Tocher based his 3 per cent on 8·38 per cent of animals. On the same lines, from the fat distribution, it is worthy of note that 94 samples, or 3·33 per cent, showed fat content less than 3·5 per cent, and 219 samples, or 7·78 per cent, had a fat content less than 3·80 per cent. Hence, it is more reasonable in Egypt to consider the lowest limiting figure of fat nearly about 3·80 per cent, certainly not 3·0 per cent. As regards solids-not-fat, Tocher found that the average figure was 8·87 per cent, and the least limiting figure was 8·50 per cent for 24·70 per cent of animals. If such lowest figure was applied in our herd it would correspond to 8·01 per cent of samples; hence it is quite fair to consider the lowest limiting figure 8·80 per cent, which corresponds to 22·15 per cent of the samples.

It is therefore more correct to consider in the Egyptian milk regulations the lowest figure of fat to be 3·80 per cent and of solids-not-fat 8·80 per cent, instead of 3·0 per cent and 8·50 per cent respectively. To these can be added the total solids and the ratio of fat to total solids; the former should be 12·60 per cent and the latter 30·10 per cent.

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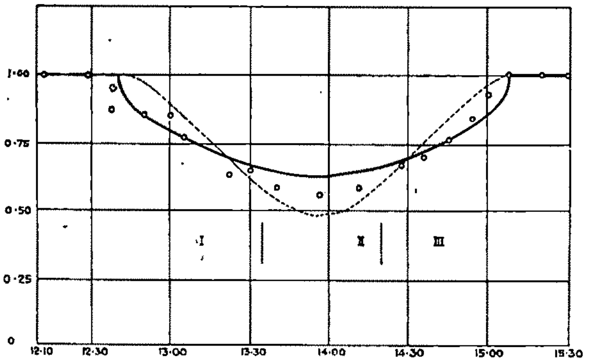
Radio Noise from the Sun at 3·2 cm.

IN connexion with Dr. Martyn's recent communication[1], the following measurements made by me at Malvern during the partial eclipse of July 2, 1945, may be of some interest. They were made at a wavelength of 3·2 cm., using an apparatus similar in principle to that described by R. H. Dicke[2] in conjunction with an antenna consisting of a wave-guide-fed paraboloid 3 ft. in diameter. The beam width was about 2°.

The results obtained are shown in the accompanying figure, together with two comparison curves. The full curve represents the fraction of the sun's circumference, and the dashed curve the fraction of area of the sun's disk exposed during the course of the eclipse.

The weather divided the experiment into three periods. During period I there was heavy cloud



Hours G.M.T.
——, fraction of sun's circumference exposed ;
- - - -, " " " area " ;
o, experimental points ;
Absolute value of sun's radiation = 4×10^{-18} watts/mc./s./cm.[2]

almost totally preventing visual alignment. A time constant of 1 sec. on the output meter rendered electrical alignment rather difficult, so errors due to misalignment may be present. In period II atmospheric absorption was appreciable, rain fell and eventually stopped measurements for a while. Measurements of atmospheric absorption were made together with the solar measurements, and correction applied, but the results may quite possibly be too low. In period III measurements were started again with visibility rapidly improving, and frequent visual sights were made.

Although the observed values do not fit one curve better than the other, there are at least two factors which must be considered. First, even if all the noise originates at the sun's circumference, the source would not be of infinitesimal width, and some rounding off of the sharp corners of the full curve would be expected. Secondly, it is to be expected that some noise comes from the whole disk, and the trough would thus be deepened to a certain extent. The accuracy of the measurements does not warrant much effort in deducing the detailed distribution of the noise sources, but they do indicate that the sources are mainly located about the circumference.

The value of the total radiation from the sun was found to be 4×10^{-18} watts/mc./s./sq. cm.

I wish to thank the Chief Scientist of the Ministry of Supply for permission to publish these results.

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Feb. 18.

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[1] *Nature*, 158, 632 (1946).
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Crystal Structure of a Crossed-Chain Potassium Soap

IT is generally assumed that hydrocarbon chains in soaps all lie parallel to each other, although experimental evidence on this point has hitherto been lacking. Soaps crystallize in a bewildering variety of crystalline forms[1], and whereas the axes of the chains may lie parallel in some forms, they do not necessarily do so in all of them.

In the case of potassium soaps, we have encountered at least three forms, provisionally designated A, B, C of anhydrous, and one form D of hydrated, neutral even-numbered potassium soaps, each giving a different characteristic X-ray powder pattern. The form A is monoclinic, and was obtained for soaps with 4–12 carbon atoms in the chain ; long spacings d measured in kX. obey a formula, $d = 5{\cdot}70 + 2{\cdot}165 N$, where N is the number of carbon atoms in the chain. The angle of tilt between the chain axes and the (001) plane (calculated from the increment, assuming tetrahedral angle and carbon to carbon bond-length 1·54 kX. in the chain) is therefore 59·4°.

The form B is probably triclinic ; it was obtained for soaps with 12–18 carbon atoms per molecule. Long spacings obey the law $d = 6{\cdot}80 + 1{\cdot}95 N$; the angle of tilt is therefore 50·7°.

The form C was observed only at higher temperatures, and the hydrated form D at lower temperatures ; they have not yet been studied in sufficient detail to warrant description. Piper[2] reports only one form each of neutral and acid potassium soaps, and the neutral soaps of longer chain-length investigated by him may be identical with our form B.

We were fortunate in growing a few single crystals of the monoclinic form A of potassium caprate ($KC_{10}H_{19}O_2$), large enough for a single-crystal X-ray examination, and prepared Fourier projections along the a and b axes. They revealed that in this form of soap the molecules are in general positions and the hydrocarbon chains cross each other at an appreciable angle.

The crystals were grown from ethanol by very slow evaporation over calcium chloride. They are extremely thin plates, the large face being {001}, with malformed edges. They are stable on exposure to the dry air, but disintegrate (probably forming the hydrated form D) when exposed to air of ordinary humidity at temperatures below room temperature. Dehydration experiments showed that they are anhydrous.

Rotation, oscillation and moving film photographs were taken about the a and b axes using copper $K\alpha$ radiation. The crystal is monoclinic and the unit cell dimensions are : $a = 8{\cdot}09$ kX., $b = 5{\cdot}63$ kX., $c = 28{\cdot}81$ kX., $\beta = 108°$, d (001) = 27·40 kX. ; density (meas.) 1·123 gm./c.c., (calc.) 1·112 gm./c.c. (assuming four molecules per unit cell) ; halvings observed were : ($h0l$) absent when h is odd ; ($0k0$) absent when k is odd ; therefore, the space group is $C_{2h}^{5} - P\ 2_1/a$.

The intensities of the reflexions were estimated by eye and the signs of most of the structure factors determined by trial and error. In the Fourier projection along the b axis, the plane zigzag hydrocarbon chains project parallel to each other and edge on. Moreover, owing to a component of tilt in the plane perpendicular to the plane of projection, pairs of carbon atoms of the same chain overlap, with the exception of the terminal groups. The electron density distribution is consistent with the zigzag configuration, and, assuming the usual interatomic angles and distances, approximate x and z co-ordinates have been determined. The component of the angle of tilt projected along the b axis, measured from the a-axis, is approximately 102°. In the Fourier projection along the a axis the chains are seen face-on and form a criss-cross pattern, one chain making on the projection an angle of about 58° ; the other, in conformity to the symmetry of the crystal, an angle of about 122°, both measured from the b-axis. The co-ordinates of the atoms are being refined.

We are indebted to Dr. J. Iball for valuable advice, and to the director of the Chester Beatty Research Institute of the Royal Cancer Hospital (Free) for the loan of some apparatus. We wish to thank the directors of Lever Brothers and Unilever Ltd. for permission to publish these results.

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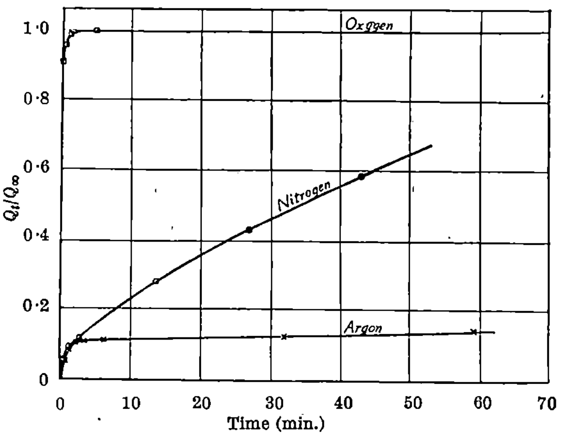
Molecular Sieve Action at Low Temperatures

BY using crystalline network lattices with uniform interstices as sorbents, it has proved possible to carry out a great many resolutions of molecular mixtures[1]. Molecules which are of the right dimensions to enter and occupy the intra-crystalline interstices are then removed by selective sorption, leaving behind molecules which are too large or have the wrong shape, and hence toward which the network lattice is a non-sorbent. Crystalline parameters define with precision the dimensions of the interstices (which are linked to give channels); and, therefore, the molecular sieve action is equally clearly defined. As a result separations become quantitative in numerous instances (for example, *n*-paraffins from *iso*-paraffins using dehydrated chabazite as sorbent).

Between these two extremes lies a transition group of molecules which work their way slowly into the crystal by a process of activated diffusion[1]. Indeed, there is a complete range of velocities of sorption between the extremes. Some molecules are sorbed rapidly at room temperatures, but more slowly at −78° C. (for example, argon and nitrogen in calcium and barium mordenites). Then one finds a very low energy of activation for diffusion[2]. (This energy of activation is not due to chemical forces, but is a reflexion of the periodic potential energy field in the crystal encountered by the molecule as it moves from one site of maximum sorption potential to the next.)

It has now been found that the molecular sieve behaviour can be extended considerably by sorbing those gases with a small energy of activation for diffusion at still lower temperatures (−183° to −195° C.). In this way, for example, using a suitable molecular sieve sorbent, great differences in the sorption-rates of oxygen, nitrogen and argon were found, which seem quite sufficient to permit quantitative or semi-quantitative resolutions of their mixtures. The sorption-rates at − 184° C. were as expected in the order oxygen > nitrogen > argon, in the inverse relation to the dimension important for diffusion down a narrow interstitial channel, namely, the cross-sectional diameter normal to the molecular axis in oxygen and nitrogen molecules, and the diameter of the argon atom respectively[1,2].

As an illustration, the accompanying graph shows the relative amounts of argon, nitrogen and oxygen sorbed by 1 gm. of dehydrated levynite at − 184° C. at various times. Apart from a small and rapid sorption on external surfaces of the crystal powder, argon is sorbed at a very slow rate. Moreover, if a mixture of argon and oxygen were passed through the powder at − 184°, by adjusting the time of contact to one or two minutes, one would here expect a 99 per cent removal of oxygen from the mixture.



WIDELY DIVERGENT SORPTION-RATES IN DEHYDRATED LEVYNITE AT − 184° C., DUE TO THE MOLECULAR SIEVE ACTIVITY OF THE ZEOLITE

Q_t denotes c.c. sorbed at N.T.P./gm.

Q_∞ denotes sorption at equilibrium in c.c. at N.T.P./gm.; oxygen, 10·02 c.c./gm.; nitrogen, 9·77 c.c./gm.; argon, 10·13 c.c./gm.

Such contact times would also give a good separation of nitrogen from oxygen. These results, particularly on argon – oxygen mixtures, should be of interest to the argon industry, and the liquid air industry. The experiments also demonstrate for the first time that levynite, like chabazite[3], gmelinite[2], mordenite[2] and certain synthetic zeolites[4], has molecular sieve activity.

A full account of these and other results will be published elsewhere.

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Jan. 31.

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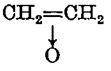
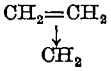
Structures of Ethylene Oxide and Cyclopropane

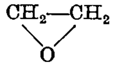
IT has recently been suggested by Walsh[1] that the structures I and II represent the properties of ethylene oxide and cyclopropane better than do the classical formulæ III and IV. In these new structures the oxygen atom in I, and the CH_2 group in II, are attached to the double bond by a dative link formed from the π-electron pair of the 'ethylene' portion of the molecule. These ideas were apparently put forward because Zimakov[2] has lately pointed out that the classical Würtz formula for ethylene oxide does not adequately account for its high reactivity; also because formula IV gives no indication of the characteristic reactivity of cyclopropane.


$$\underset{\displaystyle O}{\overset{CH_2{=}CH_2}{\downarrow}}$$

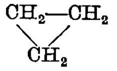
I


$$\underset{\displaystyle CH_2}{\overset{CH_2{=}CH_2}{\downarrow}}$$

II



III



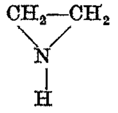
IV

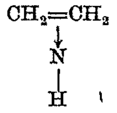
The conception of π-electron dative bonds is due originally to Dewar[3], and though it does help to explain certain molecular rearrangements, its use in the suggested structures makes it difficult to reconcile these with the known Raman and infra-red spectra of ethylene oxide and cyclopropane. If the double bond in structures I and II has the properties usually associated with such a linkage, then both these compounds should show a strong Raman band (polarized) in the region of 1,600 cm.$^{-1}$ due to the $>C = C<$ vibration: in ethylene[4] this band occurs at 1,623 cm.$^{-1}$.

Both structures I and III belong to the point group C_{2v}; the irreducible representations for vibrations of this point group are $5A_1+3A_2+4B_1+3B_2$, of which all are allowed as fundamentals in the Raman spectrum, while the A_2 vibrations are forbidden in the infra-red spectrum. The A_1 vibrations in the Raman spectrum are polarized, hence if structure I were correct we should also get a band in the infra-red spectrum in the region of 1,600 cm.$^{-1}$. The Raman and infra-red spectra of ethylene oxide[5], and of the related ethylene sulphide[6], are well known; but there are no Raman bands near 1,600 cm.$^{-1}$ in the spectra of either of these compounds; and the observed spectra are in conformity with the requirements of the symmetry group C_{2v}.

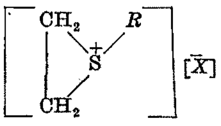
Cyclopropane as represented by structure IV belongs to the point group D_{3h}, which has as irreducible representations $3A_1' + 1A_1'' + 1A_2' + 2A_2'' + 4E' + 3E''$, of which the A_1'', A_2'', and A_2' vibrations are forbidden in the Raman spectrum and only the E' and A_2'' vibrations allowed in the infra-red spectrum. The A_1' vibrations in the Raman spectrum are polarized. The Raman and infra-red spectra of this compound have been examined by a number of workers[5], and the experimental results confirm these deductions. Again, no Raman line is found near 1,600 cm.$^{-1}$.

Further, and perhaps more conclusive evidence, could be obtained if the Raman and infra-red spectra of ethyleneimine V were examined; for if this compound has a π-electron dative bond as in VI, then the frequency of the N—H vibration should be different from the value usually found for this linkage when the nitrogen is part of a heterocyclic system.

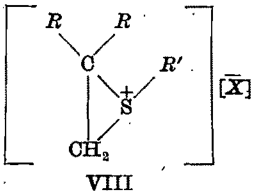

V


VI

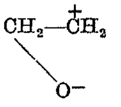
From the purely chemical point of view, there is also evidence against a π-electron dative bond in these substances, for Delépine[7] has found that ethylene sulphide forms crystalline sulphonium compounds of the type VII.

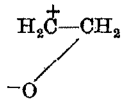

VII

In this connexion it is interesting to note that the sulphonium ions of compounds of the type VIII are asymmetric and should exhibit optical isomerism, since they are analogous to those organic sulphur compounds which have been successfully resolved[8]. In fact, if compounds like VIII were resolvable, it would be strong evidence against the occurrence of a π-electron dative bond in ethylene sulphide.


VIII

Thus, though structures I and II are suggestive, it is difficult to accept them as representing ethylene oxide and cyclopropane. In the case of the former there seems no reason, at the moment, to go beyond Zimakov's suggestion that it be regarded as a resonance hybrid in which structures IX and X predominate.


IX


X

This would account adequately for the reactivity of this substance and yet be consistent with the known Raman and infra-red spectra. The reactivity of cyclopropane could also be ascribed to resonance between analogous structures.

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[2] Zimakov, *Acta physiochemica U.R.S.S.*, 21, 401 (1946).

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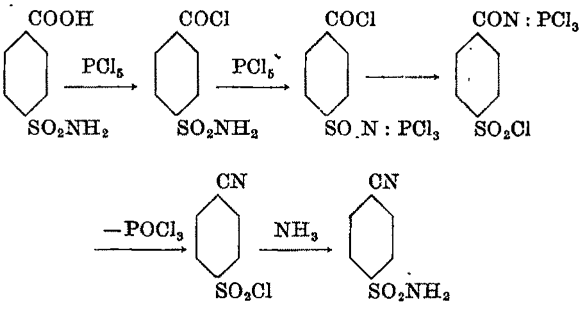
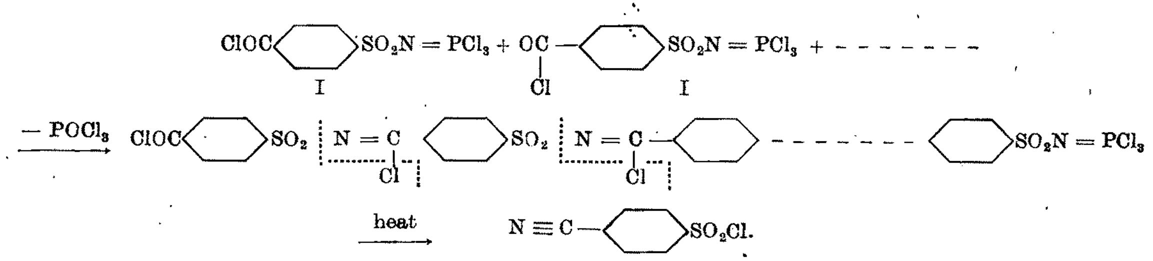
Action of Phosphorus Pentachloride on *p*-Sulphonamido Benzoic Acid

Remsen *et al.*[1], in the preparation of *p*-sulphonamido benzonitrile from *p*-sulphonamido benzoic acid by the action of phosphorus pentachloride, postulate the following mechanism of reaction:



They remark on the shift of the nitrogen from the sulphone group to the carbon atom attached to the para position of the ring, but do not explain it. The following explanation of the mechanism is offered.


ClOC SO₂N = PCl₃ + OC SO₂N = PCl₃ +
Cl
I
I
I
− POCl₃
ClOC SO₂ N = C SO₂ N = C SO₂N = PCl₃
Cl
Cl
heat
N ≡ C SO₂Cl.

It is supposed that several molecules of the chloride (I) condense as indicated to form polymers, phosphorus oxychloride being eliminated. The resultant polymer then breaks down on further heating, to give the required *p*-sulphonamido benzonitrile. In support of this hypothesis, compounds of the type $R.SO_2N{=}C(Cl)R'$ are known to dissociate on heating as follows[2,3,4]:

$$R.SO_2N{=}C(Cl)R' \rightarrow R.SO_2Cl + R'CN.$$

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Oxford. Feb. 5.

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[1] Remsen, Hartmann and Muckenfuss, *Amer. Chem. J.*, 18, 150 (1896).

[2] Wolkowa, *Ber.*, 5, 139 (1872).

[3] Kemp, A. D., M.Sc. thesis, University of the Witwatersrand.

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A Proposed Test for 'Sterilized' Milk

THE need for a simple and satisfactory test to indicate the probable keeping quality and sterility of 'Sterilized' milk is becoming increasingly urgent. The phosphatase test of Kay and Graham may not always give satisfactory results when applied to 'Sterilized' milk because the reaction is affected by products produced in the milk as a result of the severe heat treatment.

The most common and important type of spoilage of 'Sterilized' milk is sweet curdling[1]. This fault may occur in bottles of milk with the vacuum unimpaired in as short a period as three days after sterilization. The organisms responsible are usually atypical forms of *B. cereus* and *B. subtilis* which produce a rennin-like enzyme and, also, because of the reduced oxygen tension in the milk, carbon dioxide. The heat treatment to which the milk is subjected (at least 212° F. for a period of not less than 10 minutes) causes a decrease in the amount of soluble calcium, but the carbon dioxide produced by the organisms renders sufficient of the calcium soluble for the rennin to clot the milk.

Types of spoilage which occur with less frequency are the development of 'oxidized' or 'cardboard' flavour due to the presence of large numbers of *B. circulans*, which also appears to produce a rennin-like enzyme in milk, and 'bitter' flavour which is produced by *B. thermoacidurans*.

It has been shown that the alcohol test can be used to indicate the keeping quality of raw milk, and that milk containing a large number of rennet-producing organisms can be detected by this test[2].

From these researches it appeared feasible that the alcohol test might be modified to indicate the keeping quality of 'Sterilized' milk. Preliminary experiments have shown that when milk containing spores of *B. subtilis*, *B. cereus* or *B. licheniformis* after sterilization is incubated at 37° C. for 27 hours and then tested by the alcohol test using 80 per cent (sp. gr. 0·848) alcohol containing 0·02 per cent neutral red, those samples which gave a precipitate developed bitterness or sweet curdling within a period of three weeks when held at room temperature, that is, the period within which the milk may be held before sale to the public. If in addition to the precipitate there is an acid reaction, it is probable that the milk is contaminated with streptococci which have gained entrance to the milk after heating, or with acid-producing sporing aerobes such as *B. albolactis* (Mig.) and *B. thermoacidurans*. These organisms are, however, not commonly found in 'Sterilized' milk. On the other hand, if the reaction is slightly alkaline, the contamination is probably due to spore-forming organisms present in the bottles before they were filled with milk.

These preliminary experiments will require to be extended in order to define the exact correlation between the results of the test and the keeping quality of the milk.

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44 Orchard Lead Road,
Edinburgh. Jan. 29.

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[1] Morgan, G. F. V., *Proc. Soc. Agric. Bact.* (Abstracts), 31 (1943).

[2] Chalmers, C. H., *J. Bact.*, 15, 93 (1928).

Influence of Heteroauxin on the Cotyledons of *Phaseolus vulgaris* L.

I THINK it is only right that attention should be directed to certain facts concerning the communication from A. Malabotti, published in *Nature* of December 14, 1946, under this title. The work described there, far from being recent, was carried out at the Biological Research Institute of the Academy of Science in Vienna more than ten years ago, when I was director of the Institute. Malabotti was one of my students, and the work was done at my suggestion and under my supervision to supplement my own experimental work on the same subject. Accounts of the work have already been published by Malabotti[1] and myself[2,3]. A comparison of Mr. Malabotti's communication in *Nature* with my paper of 1937 shows that it is an almost literal translation of the latter, with the addition of two photographs and their explanations.

Since 1939 I have been working at the Jodrell Laboratory at the Royal Botanic Gardens, Kew, and, during part of this time, have continued my researches on the effect of heteroauxin on *Phaseolus vulgaris*, a full account of which was published[4] with due acknowledgment to Malabotti for his past collaboration.

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[1] Malabotti, A., *Anz. Akad. Wiss. Wien, Math. Naturwiss. Kl.*, No. 13 (1937).

[2] Portheim, L., *Anz. Akad. Wiss. Wien, Math. Naturwiss. Kl.*, No. 17 (1936).

[3] Portheim, L., *Anz. Akad. Wiss. Wien, Math. Naturwiss. Kl.*, No. 13 (1937).

[4] Portheim, L., *Ann. Bot.*, n.s., 5, No. 17, 35 (1941).

SCIENCE AND THE REAL FREEDOMS

THE critical economic situation in which Britain finds herself requires all possible scientific help. The contribution of men of science can be as vital to our national recovery as any gains won by the miners in the battle for coal. But this depends on whether men of science are in a position to act, and whether their efforts are properly organised and integrated on a national scale.

The speakers at a recent conference on "Science and the Real Freedoms" convened by the Association of Scientific Workers dealt with these issues so far as they affect the freedom of men of science to develop their knowledge and the opportunity to see it applied to the main economic problems of the country. In opening the meeting, Sir Robert Watson-Watt pointed to the substantial progress that has been made towards the planning of scientific effort. Members of the Association particularly welcome the formation of the committees for military and civil science under the chairmanship of Sir Henry Tizard. Also encouraging are the scientific organisation within the National Coal Board and the provisions of the Industrial Organisation Bill. But still there remain severe limitations on the development and use of science, which we would be unwise to ignore.

The scale and nature of the effort applied to the development of new weapons of war, which offer us the possibility of mass destruction of quite unprecedented extent, is a source of disquiet. The man of science, as a key man in this development, works behind the screen of military security, cut off from free intercourse with other scientific workers by dangerously ill-defined and ill-conceived secrecy restrictions. The Official Secrets Act, which someone once quite seriously described as "the Act to repeal Magna Carta", is singularly unclear in the burdens, often of retrospective responsibility, which it puts on State servants and ordinary citizens alike. Safeguards are essential, but they should be specific, clear, comprehensible and limited. At present it seems that timid minds are imposing a stricter and more extensive secrecy than is necessary, with the result that our own scientific progress is perhaps hampered as much as that of a potential enemy.

Restrictions, Sir Robert said, are not confined to the military field. It is the habit of industrialists to accuse the bureaucrat of an exclusive taste for restrictions. However, they themselves must take some of the blame for certain economic shortcomings. For a long time sections of industry have imposed limitations on the development and interchange of new ideas and techniques, occupied research workers on circumventing the patents of others, and used blocking patents of their own to ward off the necessity of making new capital investments.

Talk on 'freedoms' has been too much directed to the passive freedoms, 'freedoms from'; and too little to the active freedoms, 'freedoms for' and 'freedoms to'. While men of science have been accustomed to claim for themselves the right to choose, to learn, to read, speak, think and write as they will, they have not put enough effort into the harder task of winning the freedom to investigate, to study scientifically within the industries themselves and by their own methods the problems which they consider important to the life of the community. The scientific worker in industry is seldom given the chance to investigate adequately the problems of production and development in his section of industry, nor is he in a position to undertake the full application of war-time discoveries to production techniques. There is clearly an urgent need of extension of freedom to penetrate in this direction.

Sir Robert Watson-Watt ended with a word of caution. It should be remembered that the outcome of any project of scientific research is unforecastable. As men of science we cannot say explicitly at the outset what may be expected from the investigations which we feel we must be free to undertake. The user does not know what to ask for; the investigator does not know what he can promise. But as to the great advantages which will arise from the organised application of research and scientific method, we have no doubts and many proofs. The opportunity which men of science now have of proving the value of their methods in overcoming our economic difficulties must not be lost.

Dr. E. H. S. Burhop, former member of the British team of atomic scientists in America, spoke of the loss of what might be called the natural rights of men of science. Such men have advanced fundamental knowledge in the past, because there have been free exchange of information and collaboration across frontiers and between workers in the different branches of science. Now secrecy has split them in camps, and the ominous delay in ending it is a symptom of the preparation of another world war. In view of the great dangers involved, the Association of Scientific Workers feels that it is time for men of science to decide what they can do collectively and individually to better this situation.

To one who has come to recognize a traditional fairness in British justice, some of the provisions of the Official Secrets Act are alarming. Under it the normal rights of citizens to a fair trial are superseded, and the onus of proof of innocence is placed on the accused. It is not necessary, Dr. Burhop said, for the prosecution even to prove that any specific offence has been committed; only that the character of the accused makes it appear probable that he has committed such an offence. Moreover, many people are under the misconception that this Act applies only to those in Government service. In fact it applies to everyone in the country.

We have, as a warning of what might happen, the hysteria and false accusations which followed the revelations of a spy-ring in Canada. There is also the case of Dr. Nunn May, which arose similarly out of the secrecy Britain and the United States have imposed on the atom bomb. While the Association does not condone his offence, to which he himself had pleaded guilty, it did feel justified in asking for a marked reduction in his ten-year sentence. If the harshness of this was intended as a deterrent on other men of science, it was a success in so far as it made many have second thoughts about taking any part at all in the development of atomic energy in Britain.

Dr. Burhop recalled the circumstances of the ban placed on certain British and American scientific workers from travelling to Moscow, when the war with Germany had ended, and the Japanese war was in its last stages. He doubts if any atomic physicist would even now have the temerity to apply for permission to travel to the U.S.S.R. or Eastern Europe. As new techniques of mass destruction are developed, the ban might involve other scientific workers besides the atomic physicists.

The Association advocates the complete publication of all results of scientific research, which has been suppressed for reasons of military security, as soon as the Security Council is operating a plan which outlaws the use of weapons of mass destruction, and which provides for a general reduction and control of armaments. Even while the present situation continues, secrecy should be confined to certain technical aspects of weapon development. As a means of re-establishing wide international relations, continued support for U.N.E.S.C.O. and for the recently formed World Federation of Scientific Workers is essential. Moreover, men of science, including those working on atomic energy, should be allowed and encouraged to visit workers in other countries.

We have to be vigilant concerning national restrictions on the freedom of men of science. Under the Atomic Energy Act scientific workers have no well-defined rights of access to scientific information connected in any way with atomic energy. Decisions on these matters depend on the Minister of Supply and his official advisers, and the effects of these decisions will have to be carefully watched. Wherever they work, men of science should have a legal right to the publication of their results. All should be employed on the basis of service contracts, in which are clearly defined their rights and duties in their particular job.

Prof. J. D. Bernal opened his address with the words: "The real freedoms of science not only include freedom from crippling restriction, but freedom to give of one's best in the service of the community. Such freedom is more than individual freedom. It is a collective freedom implying organisation of scientists by scientists in relation to all aspects of national activity."

There is nothing essentially new in the serious economic situation which confronts us to-day. As a culmination of our failure to organise and use our scientific resources efficiently, it has proved conclusively our worst fears and forecasts. Only men of science can see where and for what purposes they themselves are needed. It will be on their own initiative that they will take part in the national recovery.

The White Paper on the economic situation is no more than an able diagnosis of the trouble. When it comes to the cure, all it offers are pious hopes. Unless there is energetic planning, even the necessary minimum of a 40 per cent increase in exports will not be realized. On top of this the international situation looks as though it might get worse in the coming year.

In maintaining our present foreign policy we are keeping 1½ million of our twenty million workers in the Armed Forces. About half a million more are engaged on the production of military supplies. The wastage is relatively greater when one considers our scientific man-power. At the present time about one half of the governmental scientific expenditure is allocated to military research, and clearly the ending of war preparations would release a larger proportion of scientific workers for productive work.

The essential and most urgent need is to consider the best way of organising scientific effort for helping to solve the short- and long-term problems facing us in the industrial sphere in Great Britain. We need a similar organisation and status to that of the operational research teams during the War. This is essential both in those Ministries responsible for our industries, and within the national development councils envisaged under the Industrial Organisation Act. In addition, men of science are needed at Cabinet office level working in co-operation with the Joint Planning Staff. The existence of the Tizard Committees provides the nucleus for such a scientific general staff.

In all this, it is clear that men of science can only analyse the situation and advise on the best policies to pursue. They can provide knowledge on which wise action could be based, but not the action itself. It is up to the Government to take adequate powers to ensure the implementation of the policies decided upon.

About the responsibilities of men of science, Prof. Bernal urged that they take active steps to ensure the widest possible knowledge of the technical situation of the country. The Tizard Committees cannot become fully effective in a normal Civil Service atmosphere, unless there is a possibility of mobilizing public opinion for research and against obstruction. It needs sustained activity on the part of scientific workers to see the necessary plans through to successful completion.

In the discussion, two delegates from the Amalgamated Engineering Union spoke of the attitude of the factory workers to scientific developments. The workers do not take kindly to innovations when, as in one factory, output was trebled but wages scarcely raised. Nor can they easily understand the attitude of the man of science, when he speaks of the importance of freely sharing his knowledge. In the artisan class, particularly, there is a tendency not to pass on information, since in times of unemployment only the most skilled and valuable men keep their jobs. It is necessary for the men of science to explain their methods and to prove their value to the working people. In that way they would win the willing co-operation of the trade union movement.

HEREDITARY (SEED-BORNE) SYMBIOSIS IN *CASUARINA EQUISETIFOLIA* FORST.

By Prof. S. R. BOSE

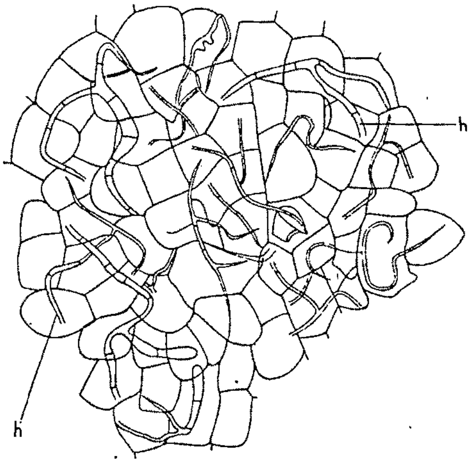
Carmichael Medical College, Calcutta

EVERY *Casuarina equisetifolia* plant examined has been found to have mycelia of *Phomopsis casuarinæ* F. Tassi extending throughout into every organ, beginning from the seed-coat. Cutting a section of the seed-coat of *Casuarina* and staining in picro-nigrosin or cotton blue one can see finely branched and septate hyphæ within the tegmen (see accompanying illustration). Only the resting embryo with two cotyledons is free from fungal infection. In samples of tomato and apple seeds from some apparently healthy fruits from Calcutta markets, I have seen a network of copiously branched and septate hyphæ in the tegmen under the microscope. Dennis[1] recently remarked that "fungi capable under favourable circumstances of parasitizing economic plants such as potato, tomato and apple may be found in nature as saprophytes on herbaceous weeds". I wonder whether Dennis had examined microscopically sections of clean seeds of the various economic plants to locate any possible *Phoma* hyphæ within the tegmen before planting them in the virgin soil. Oxley and Jones[2] found, under the epidermis of maize seeds, and seeds of many samples of English wheat and some Canadian wheat, abundant mycelia in the vegetative condition which they have not been able to identify nor to bring out in pure culture. In some samples of local wheat and maize seeds and some American maize, I have also obtained distinctly septate and branched hyphæ beneath the testa within the tegmen; from a maize sample *Ascochyta* sp. has been isolated in pure culture in malt agar tube, the seed germinated well in the course of five days and the fungus came out with two-celled, oblong and muticate conidia. Bessey[3] and Dennis[1] regard *Ascochyta* as essentially a *Phoma* with two-celled conidia. It would be of interest to know the function of these hyphæ within the seed coat, whether they have any connexion with germination and growth of the wheat and maize plants.

For a number of years I have had opportunities of examining roots, stems, green branchlets, cones, young fruits and fruit-stalks, seeds—young and mature—of *Casuarina equisetifolia* trees of different ages and from different areas of Bengal, Bihar, Orissa, Madras, Bangalore, etc., including a large number of healthy seedlings raised in the nursery of the Royal Botanical Garden, Calcutta, and later I received fruits, seeds and branchlets of *Casuarina equisetifolia* from Australia (Queensland and Brisbane), mainly through the kindness of Dr. J. McLuckie. In each case the same type of fungus (hyphæ of *Phomopsis casuarinæ*) was found co-extensive with the growth of the plant, occurring practically in every organ of the plant.

The results of my experiments with a number of seedlings of *Casuarina equisetifolia* in humus soil with pure culture of *Phomopsis casuarinæ*, as well as experiments to lower the physiological condition of pot-plants by keeping them confined within a glass chamber for about two weeks, confirm the observations of Melin[4] and How[5] that the physiological condition of the host determines the nature of relationship between the two partners in a mycorrhizal association; very weak seedlings in a moribund condition and pot-plants in abnormal condition were killed outright by the fungus, which became strongly virulent and parasitic, while slightly weak but normal seedlings were greatly invigorated by the fungal inoculation, thus establishing examples of well-balanced mycorrhizas. According to Roger Gosselin[6], *Polystictus circinatus* begins as mycorrhizal growth in the roots of spruce during the early period and stimulates the growth of the host plant; ultimately it travels towards the butt of the tree and produces butt-rot. He found that butt-rotted trees have a greater rate of growth than those not rotted, and could produce evidence of mycorrhizal association by inoculation of spruce seedlings with pure culture of *P. circinatus*. This case runs somewhat parallel to that of *Phomopsis casuarinæ* in *Casuarina equisetifolia*, where the fungus first begins as a symbiont but ultimately brings on death of the plant or, in cases, some of its parts, as a parasite; finally, it persists as a saprophyte to be succeeded by *Ganoderma lucidus*, *Fomes senex*, *F. durissimus*, *F. fastuosus*, *Polyporus calcuttensis*, etc., as members of a fungal complex.

Hahn's[7] experience with fruiting bodies of *Phomopsis juniperovora* on *Juniperus virginiana* was that, on vigorous plants growing in the open, the fungus could not be traced in spite of a careful and intensive search, but on suppressed cedars growing in a damp situation in the Platte River or on their withered and dead branchlet-tips the parasite could be found, and abundant fruiting was readily detected on blighted branchlets of a number of cedars used as hedge-plants and on transplant nursery stock used for ornamental purposes; all these observations led Hahn to suspect "if the cedar blight is seed-borne". In this connexion one might refer to the experience of Shear and Wood[8], who have demonstrated the presence of latent infection by *Glœosporium* and *Colletotrichum* in leaves, stems and fruits of a number of plants apparently healthy, and to the experience of Campbell and others[9] in oak heart-wood, where they frequently encountered a number of non-decay-producing fungi and some from apparently sound heart-wood; the exact cause of their presence cannot be ascertained, though it has been surmised that they might have some effect on entrance and subsequent spread of heart-wood-decaying species as forerunners of a fungal complex. Strasburger[10], discussing swellings on leaves of tropical plants belonging to the families of Rubiaceæ and Myrsinaceæ, due to infection by bacteria, has observed that these bacteria are present in the embryo of the plant, and that when these bacteria are artificially kept from the egg-cell, the development of *Ardisia* is abnormal. Parkin[11] has described a curious symbiosis between the fungus *Stereum sanguinolentum* and two siricid woodwasps; he asks why, of many and similar soft wood-attacking fungi, should *Stereum sanguinolentum* only be associated with these two woodwasps? Evidently these problems require further investigation.



PORTION OF THE TEGMEN OF SEED OF *Casuarina equisetifolia* SHOWING SEPTATE HYPHÆ (MARKED *h*) OF *Phomopsis casuarinæ*, CAMERA LUCIDA SKETCH AT TABLE-LEVEL WITH LEITZ EYEPIECE NO. 5 AND OBJECTIVE NO. 7. (× c. 275)

Besides the fungus (*Phomopsis casuarinæ*), *Casuarina equisetifolia* bears coralloid roots or nodules due to infestation of the bacteria, *Rhizobium casuarinæ*, nov. sp. Dowson, which, according to A. Blake[12] and others, fix considerable quantities of nitrogen from the air. The roots of the plant also possess root-hairs at their growing ends. The fungus probably absorbs ammonia salts and complex organic nitrogen-compounds such as nucleic acid and peptone, and transfers them to the roots, as held by Melin[4]; probably auxins and vitamins accumulated by hyphæ are translocated to the roots (cf. MacDougal and Dufrenoy[13]), and the molecular nitrogen fixed by bacteria (amino-acid) is probably made available throughout the body of the plant; the fungus in return gets its supply of carbohydrates from the tree and of phosphatids exuded by its roots. The evidence for nitrogen-fixation from the air by the fungus is very meagre and is not of much consequence. Thus, it is a clear example of close co-operation among the three—the plant, the fungus and the bacteria—for successful and healthy growth of the tree.

I think future work may show if the much discredited mycoplasm theory of Eriksson will be explained by the discovery of hereditary (seed-borne) symbiosis in many plants where a perennial mycelium can be detected within the tegmen of the seeds.

Details of this work, with experimental observations, will be published elsewhere.

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[11] Parkin, E. A., *Ann. Appl. Biol.*, **29**, 268 (1942).

[12] Blake, A., Oxford Forestry Mem., No. 14, 5 (1932).

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ELECTROSTATIC HAZARDS IN INDUSTRY

THE Institution of the Rubber Industry organised a forum to discuss "Electrostatic Hazards in Industry" on December 9 at the James Watt Memorial Institute, Birmingham. Mr. W. E. Madge (Dunlop Rubber Company) was in the chair, and the proceedings opened with five short papers each dealing with a particular aspect of the electrostatic hazard.

Mr. S. H. Wilkes (H.M. Senior Chemical Inspector of Factories), in his introductory remarks, dealt with the general principles to be borne in mind when considering electrification of materials and the consequent fire or explosion hazard. Inflammable materials—vapour, gas, or finely divided suspensions of dust—ignite only when the concentration lies within certain limits. Within this inflammability range, ignition may be caused by a rise in temperature of only a part of the system or by an electrostatic discharge. The obvious steps to take in minimizing the probability of ignition include the control of concentration and the elimination of the igniting source. Mr. Wilkes emphasized that the former must be considered of first importance; the elimination of explosive concentrations is more easily achieved in practice than the removal of all possible sources of ignition. At the same time, all reasonable steps must be taken to eliminate the occurrence of dangerous amounts of static by earthing securely all conductors, and by installing conductors instead of non-conductors wherever this is practicable.

Dr. F. J. Llewellyn (University of Birmingham) underlined the need for comprehensive laboratory data concerning the electrification and electrostatic ignitibility of substances likely to be met with in industry. Dealing with the theoretical side of ignition of dust clouds by means of electrostatic discharges, he mentioned a possible correlation between the energy stored in a condenser, the rate of dissipation, the voltage-time and current-time characteristics of the resulting air discharge and its incendivity. Discharge from a 0·01 mfd. condenser when no resistance, other than the leads and the spark gap, is included in the circuit produces an oscillatory current in the gap. The inclusion of a small resistance, say 500 ohms, completely removes this oscillatory nature; at the commencement of the spark, the current rises steeply to a high value, thereafter falling exponentially with time; the voltage meanwhile drops at the commencement of the spark to a low value and remains fairly constant until the spark ceases. The duration of the spark becomes progressively larger as this resistance increases, and the proportion of the condenser energy liberated in the spark rises to a maximum of about 30 per cent at 50,000 ohms, thereafter falling with increasing resistance. The ignition of dust clouds is most easily accomplished with sparks of short duration and high energy, that is, those obtained by discharging a condenser through a resistance of the order of 50,000 ohms.

Mr. G. Morris (Imperial Chemical Industries, Ltd., Explosives Division) discussed the electrification of powders in free-fall under gravity (Morris, *Proc. Phys. Soc.*, **51**, 1010; 1939) and also the ignition of heaps of powder by electrostatic sparks. The criterion of ignition is the energy stored in the condenser ($\frac{1}{2}CV^2$), and for small condensers is independent of the capacity. In laying down safety conditions for dealing with explosive powders, Mr. Morris found that 0·05 times the 50 per cent ignition energy gave a reasonably satisfactory upper limit for permissible electrification.

Mr. Fordham Cooper (H.M. Electrical Inspector of Factories) spoke of the causes of electrification in liquids during handling and movement. The boundary of an electrolyte such as water is normally highly polarized, having an electrical double layer, the inner and outer sides of the skin being oppositely charged. Anything which disturbs this surface will upset the electrical balance, with resultant separation of the positive and negative charges. Normally, any charges produced by the disturbance of a liquid will disappear by conduction if the specific resistance is less than 10^{10}–10^{12} ohms. The electrification of non-electrolytes presents a difficult problem; the probable explanation lies in the existence of traces of ionic or colloidal material in the liquid. Thus polar liquids such as alcohol or nitrobenzene are particularly susceptible to electrification. Mr. Cooper dealt also with the implication of stirring, and the addition of soaps; and suggested the following as precautions against fire and explosion: (*a*) increase conductivity of solvents; (*b*) use high flash point solvents; (*c*) earth all metal work, bonding discharging to receiving vessels; (*d*) keep up the air humidity; (*e*) do not introduce earthed or even unearthed conductors near the free surface of a liquid.

Mr. D. Bulgin (Research Division, Dunlop Rubber Co., Ltd., Birmingham) discussed the special electrostatic problems associated with rubber. Since the specific resistance of rubber lies between 10^9 and 10^{16} ohms, the leak-away time of static charges is very great; discharge may proceed either as a series of feeble sparks or as a brush. Whereas this direct discharge is usually of insufficient energy to cause ignition of inflammable vapours, induced charges on nearby conductors can become a serious hazard. Mr. Bulgin outlined the various methods available for minimizing this risk, both in the production of rubber goods and in their utilization. He described also a valve-voltmeter which he has designed (*J. Sci. Instr.* **22**, 8; 1945) which is extremely valuable in detecting the build-up of electrostatic voltages and in surveying rapidly the electrification produced at various stages in the processing of a material.

The five papers will be fully published elsewhere in due course.

CENTENARY OF KING'S COLLEGE (LONDON) ENGINEERING SOCIETY

THE Engineering Society of King's College, London, celebrated the centenary of its foundation during March 5–8. It is thus one of the oldest institutions of its kind in Great Britain, for its first meeting was preceded by only six days by the inauguration of the Institution of Mechanical Engineers. The oldest engineering institution in Great Britain, the Civil Engineers, was formed in 1818 and received its Royal Charter in 1828; the Société des Ingénieurs Civils de France was not formed until 1848.

The celebrations opened on March 5 with a thanksgiving service in the College chapel, conducted by the chaplain, the Rev. S. H. Evans, which was addressed by the Very Rev. W. R. Matthews, Dean of St. Paul's, himself a fellow of the College. This was followed by an address "King's College Engineering Society 1847–1947", delivered by Prof. S. J. Davies in the Great Hall.

Prof. Davies began by reading the resolution passed by the eleven original members on February 2, 1847: "Resolved that a Society be formed under the sanction of the Principal and with the patronage of the Professors of King's College, London, to be called the King's College Engineering Society, and that its object be to take in the various scientific and engineering periodicals of the day and that it be hereafter extended to the reading of original papers, giving prizes . . ."

By the end of 1847 nine papers, on subjects ranging from the Niagara Falls to the solution of algebraic equations, and from daguerreotype to coal gas, had been read. The practice of electing every term a committee and officers from the students was also established.

It is interesting to note that both Prof. Wheatstone, well known for his work on electric communications, and who held the chair of experimental philosophy, and Prof. Daniell, known by his hygrometer and the Daniell cell, who held the chair of chemistry, were among the early teachers in the Department. The subjects taken covered the very wide range of engineering, applied science and architecture. The development of the undergraduate studies has been towards specialization in civil, electrical and mechanical engineering, architecture being discontinued in 1912 and metallurgy in 1918.

There has been a remarkable continuity in the progress of the Society. Apart from the First World War, there have been only two short interruptions. The first was when a Mr. Gilbert moved an amendment, to a proposition dissolving the Society, to form a "Shakespearian and Dramatic Society". This was none other than W. S. Gilbert, of Gilbert and Sullivan fame. This break lasted only two years, however, and the Society was restored to health.

As stated before, one of the objects of the Society is to provide an opportunity for members to read papers of engineering and allied interest. In the last hundred years, more than 1,100 papers have been read, an average of eleven a year. The practice of awarding prizes for papers was instituted in 1871, and it has been the practice to award two prizes every year since. A third prize, to commemorate the services to the Society of the late Prof. Ernest Wilson, to be awarded for the year's best paper, was established in 1932.

Many former students and members of the Society have risen to eminence in their profession; of eighty-two presidents of the Institution of Civil Engineers, ten have been King's 'engineers'. There have been occasions when King's 'engineers' have achieved fame in other fields; W. S. Gilbert and C. K. Bird, or "Fougasse", of *Punch*, are notable examples.

In concluding his history of the Society, Prof. Davies mentioned the *King's Engineer*, which has been published annually under the joint auspices of the Society and of the Engineering Branch of the Old Students' Association.

Prof. Davies ended his address with some remarks on engineering training in general. In particular, he compared the size of technical schools in Britain with those in Germany; he believes that better results are obtained when the engineering faculty continues as a numerically small unit within the larger body of a college.

DEW IN PALESTINE

AN account has been received from Mr. S. Duvdevani, of the Palestine Meteorological Service, of an optical method of estimation of dew which he has developed at the Dew Research Station, Pardess Hanna Agricultural School, Karkur, Palestine. The need was felt for a much quicker and less costly method than that of direct weighing of the dew collected on a standard surface, so that a network of voluntary observing stations could be organised for a country-wide study of the amount of dew in the different seasons. In a dry climate such as that of Palestine, the success of certain crops is largely dependent upon the amount of dew, and the justification for measurements with apparatus not likely to give a high degree of accuracy, in which the personal factor may be rather prominent, is obvious. Agriculturists clearly wish to know primarily where the regions of most abundant dew at the seasons when this is most important are to be found. They care comparatively little about small errors in the absolute values of the figures for the amount of dew.

The optical method arrived at after ten years of study consists in exposing a standard wooden block, called the dew-gauge, at a standard height in the open, from sunset to sunrise. Dew is estimated by reference to a standard atlas of photographs, with which the size, form and distribution of the drops on the gauge is compared. Calibration was based on a preliminary study of the measured weights of dew for various types of drop distribution recorded on life-size photographs of the gauge, a selection of which is doubtless reproduced in the atlas.

A specimen Quarterly Dew Statement published by the Palestine Meteorological Service shows that in 1946 the totals for June varied more than those for April, ranging from about 7 mm. at Ramot Ha Shavim to practically nil at Jericho. If the year was not a very unusual one meteorologically, the conclusion to be reached is that, in the Rift Valley, crops get very little assistance from dew between April and June, even when there are many clear nights, and that coastal and hill country get dew on a scale unknown in the cloudy climate of England.

E. V. NEWNHAM

FORTHCOMING EVENTS

Other entries for April 14—April 19 will be found in the issue of *Nature* dated April 5

Tuesday, April 15

ROYAL STATISTICAL SOCIETY, NORTH-EASTERN GROUP of the INDUSTRIAL APPLICATIONS SECTION (at Lemington Glass Works, Ltd., Lemington-on-Tyne), at 7 p.m.—"The Application of Statistical Control to the Quality of Blown Glass-ware".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM AND DISTRICT GROUP of the INDUSTRIAL APPLICATIONS SECTION (in the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Discussion on "Standardisation".

Friday, April 18

ROYAL INSTITUTE OF CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 3.15 p.m.—Prof. H. J. Emeléus: "Some Aspects of Nuclear Chemistry"; at 5.15 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN STATISTICAL RESEARCH—The Secretary of the Faculty of Economics and Politics, Marshall Library, Downing Street, Cambridge (April 19).

LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (April 25).

LECTURER IN SOCIAL SCIENCE—The Registrar, University College of Swansea, Singleton Park, Swansea (April 26).

TECHNICAL ASSISTANT (temporary) in the Farm Economics Branch of the Department of Agriculture for Scotland—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting No. G.96/47A (April 30).

LECTURER IN THE ECONOMICS OF COLONIAL AGRICULTURE, with special reference to co-operation, marketing and credit—The Registrar, The University, Oxford (April 30).

DIRECTOR OF PHYSICAL RESEARCH in the Admiralty—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1853 (May 8).

READERSHIP IN CHEMICAL PATHOLOGY tenable at St. Thomas's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 14).

SIR T. D. OWEN PROFESSOR OF ELECTRICAL ENGINEERING—The Secretary and Registrar, University College of North Wales, Bangor (May 17).

CHAIR OF BOTANY—The Registrar, University College, Leicester (May 17).

CHAIR OF CHEMISTRY tenable at King's College of Household and Social Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 21).

READERSHIP IN CHEMICAL PHYSIOLOGY tenable at the Royal Free Hospital School of Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 29).

BETTY BROOKES RESEARCH FELLOWSHIP—The Whitley Professor of Biochemistry, University Museum, Oxford (May 31).

DRAUGHTSMAN in the Survey Branch, Tithe Redemption Commission—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 1843 (May 31).

LECTURER IN BIOCHEMISTRY—The Professor of Biochemistry, University of Alberta, Edmonton, Alberta, Canada (May 31).

OLIVER GATTY STUDENTSHIP for the encouragement of research in the application of physical methods to biological problems—The Registrary, University Registry, The Old Schools, Cambridge (June 1).

TRAVELLING FELLOWSHIP IN GEOGRAPHICAL RESEARCH—The Director and Secretary, Royal Geographical Society, Kensington Gore, London, S.W.7 (June 1).

READERSHIP IN MEDICAL PARASITOLOGY tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 2).

PROFESSOR OF INDIAN HISTORY AND ARCHÆOLOGY in the University of Madras—The General Department, Office of the High Commissioner for India, India House, Aldwych, London, W.C.2 (Madras, June 16).

RITCHIE CHAIR OF ECONOMICS in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (June 30).

LECTURER (Grade II) and an ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (July 1).

GEOLOGIST to carry out general geological surveys and special hydrological and soil erosion studies—The Sudan Government Agent, London Office, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Geologist' (July 1).

UNIVERSITY LECTURER IN JAPANESE—The Secretary, Faculty Board of Oriental Languages, 167 Huntingdon Road, Cambridge (July 1).

ENGINEERING TEACHERS, both junior and senior and in various branches, by the Departments of Civil Engineering and of Mechanical Engineering—Dean J. J. O'Neill, Faculty of Engineering, McGill University, Montreal 2, Quebec, Canada.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Empire Cancer Campaign. Twenty-third Annual Report, 1946. Edited by J. P. Lockhart-Mummery. Pp. 186. (London: British Empire Cancer Campaign, 1946.) [3012

Proceedings of the Royal Irish Academy. Vol. 51, Section A, No. 2: The Calibration of a Photo-electric Nucleus Counter. By P. J. Nolan and L. W. Pollak. Pp. 9–32. 2*s*. Vol. 51, Section A, No. 3: A Theorem in the Charge-Symmetrical Meson Theory. By W. Heitler. Pp. 33–40. n.p. Vol. 51, Section A, No. 4: The General Affine Field Laws. By Erwin Schrödinger. Pp. 41–50. 1*s*. Vol. 51, Section B, No. 4: Quantitative Evolution, 8, Numerical Analysis of Tables to illustrate the Geological History of Species Number in Diatoms; an Introductory Summary. By James Small. Pp. 53–80 + 3 plates. 2*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [3012

Ministry of Transport. International Meeting on Radio Aids to Marine Engineering, May 1946. Vol. 2: Radio Navigation, Radar and Position Fixing Systems for Use in Marine Navigation. Pp. vi + 190. (London: H.M. Stationery Office, 1946.) [3012

British Standards 1340–43: 1946. Drawing Papers (Tracing, Detail and Cartridge). Pp. 12. (London: British Standards Institution, 1946.) 2*s*. net. [3012

A New Notation for Organic Chemistry and its Application to Library and Indexing Problems. By Dr. G. Malcolm Dyson. Pp. 26. (London: Royal Institute of Chemistry, 1946.) [3112

Éire: Roinn Talmhaíochta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Statistics of Salmon, Sea Trout and Eels captured during each of the Years 1945, 1943, 1941, 1939, 1937, 1935. (P. No. 7837.) Pp. 18. (Dublin: Stationery Office, 1946.) 6*d*. [81

Council for the Preservation of Rural England, Sheffield and Peak District Branch. Annual Report 1946. Pp. 18. (Sheffield: Council for the Preservation of Rural England, Sheffield and Peak District Branch, 1946.) [81

Birkbeck College (University of London). Calendar for the Year 1946–47. Pp. 198. (London: Birkbeck College, 1947.) [81

Other Countries

Union Internationale de Chimie. Comptes rendus de la reprise de contact du bureau, du conseil et des commissions, à l'issue de la seconde guerre mondiale, Londres, 24–27 juillet 1946. Pp. 64. (Paris: Union Internationale de Chimie, 1946.) [1212

Annals of the New York Academy of Sciences. Vol. 46, Art. 9: Blood Grouping. By William C. Boyd, J. W. Cameron, L. K. Diamond, Philip Levine, M. Melin, J. L. Oncley, Louis Pillemer, D. A. Richert, Eve B. Sonn, A. S. Wiener and Ernest Witebsky. Pp. 883–992. Vol. 47, Art. 3: Proteins and Protein Hydrolysates in Nutrition. By James B. Allison, John A. Anderson, Richard H. Barnes, David K. Bosshardt, Bacon F. Chow, Co Tui, Robert Elman, L. L. Miller, John P. Peters, F. S. Robscheit-Robbins, Robert D. Seeley and G. H. Whipple. Pp. 241–374. Vol. 48, Art. 3: Polyelectrons. By John Archibald Wheeler. Pp. 219–238. Vol. 48, Art. 4: The Effect of Artificially Altered Length of Day on Molt in the Silver Fox. By Charles F. Bassett. Pp. 239–254. (New York: New York Academy of Sciences, 1946.) [1212

Research Council of Alberta. Report No. 48: Geology and Coal Occurrences of Wapiti-Cutbank Area, Alberta. By J. A. Allan and J. L. Carr. Pp. 48. (Edmonton: King's Printer, 1946.) 50 cents. [1612

Yale Anthropological Studies. Vol. 2: Outline of Cultural Materials. Prepared by George P. Murdock, Clellan S. Ford, Alfred E. Hudson, Raymond Kennedy, Leo W. Simmons and John W. M. Whiting. Pp. vii + 56. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1945.) 6*s*. 6*d*. net. [1612

Universidad de Buenos Aires: Facultad de Agronomia y Veterinaria, Instituto de Frutiviticultura y Silvicultura. Tomo 1, Fascicolo 5: Ensayos sobre germinación del polen de manzanos en un medio artificial. Por Jorge R. Diaz. Pp. 104. (Buenos Aires: Universidad, 1946.) [1712

Cawthron Institute, Nelson, New Zealand. Annual Report, 1945–46. Pp. 39. (Cawthron: Cawthron Institute, 1946.) [1712

The University Library: its Function and Potentialities. Inaugural Address delivered in Durban on 2 September 1946. By Dr. Herbert Coblans. Pp. 16. (Durban: Natal University College, 1946.) [1912

Union of South Africa: Department of Mines. Geological Series, Bulletin No. 16: Waterberg Coalfield—Records of Boreholes 21 to 40 sunk for the Department of Mines. With Notes by J. F. Cillié and H. N. Visser. Pp. 132. (Pretoria: Government Printer, 1946.) 3*s*. [1912

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology. No. 19: Items 6047–6142, January to June 1946. By Ernest A. Hodgson. Pp. 315–330. (Ottawa: King's Printer, 1946.) 25 cents. [3012

Transactions of the San Diego Society of Natural History. Vol. 10, No. 17: The Glossy Snake, *Arizona*, with Descriptions of New Subspecies. By Laurence M. Klauber. Pp. 311–398 (plates 7–8). (San Diego, Calif.: San Diego Society of Natural History, 1946.) [3012

Department of Agriculture, Canada. Annual Report of the Forest Insect Survey, 1945. Pp. 68. (Ottawa: Department of Agriculture, 1946.) [3012

Research in Canada: Planning for the Coming Years. Papers given at the Symposium of the Chemical Institute of Canada, Quebec City, June 1945. Pp. vii + 160. (Sarnia, Ont.: Imperial Oil, Ltd., 1946.) [3012

Catalogues

The Bulletin of the House of Johnson, Matthey and Co. Ltd. Vol. 1, No. 1, October-November 1946. Pp. 24. Vol. 1, No. 2, December 1946–January 1947. Pp. 24. (London: Johnson, Matthey and Co., Ltd., 1947.)

Marmite Yeast Extract in Medicine and Dietetics. New edition. Pp. 8. (London: Marmite Food Extract Co., Ltd., 1946.)

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NATURE

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THE SCIENTIFIC INSTRUMENT INDUSTRY

THERE have been many conflicting accounts since the conclusion of the War in regard to the condition of universities, technical institutions and other educational establishments in those European countries which either endured long periods of enemy occupation or were over-run by the tides of military operations. Nevertheless, little factual information has been available of the extent to which facilities for education in science and technology survived the six years of hostilities. It was to be expected that, in the general destruction of buildings which has taken place on the Continent of Europe, and, incidentally, in Great Britain, educational establishments would have fared no better than other classes of property. On two other counts, however, it seemed probable that the facilities for the acquiring, and the pursuit, of scientific knowledge would have emerged from the War much impoverished. It was known, in the first place, that it was a policy of German occupation forces, certainly in some European countries, to repress and even to eliminate facilities for cultural advancement. In the second place, the scientific nature of the War gave a special value to scientific equipment and, although the capacity of Germany for the production of scientific instruments was very great indeed, it appeared likely that a large-scale removal into Germany of scientific instruments and apparatus might well have occurred in order to swell the German war effort.

Preliminary information which was obtained through the activities of the Science Commission of the Conference of Allied Ministers of Education indicated that the deficiency in scientific equipment on the Continent of Europe was very great indeed, and that the volume of scientific instruments and equipment required to make good this lack would be equivalent to several years normal output of the British and American scientific instrument industries. In view of the leeway to be made up in the supply of scientific equipment to educational institutions throughout the whole world, it appeared that the problem of European rehabilitation in this respect was one for which only a very long-term solution could be found. It was felt, however, that it might not be unnatural to suppose that the requirement for scientific equipment in the European countries had been over-estimated rather than under-estimated, and from the Science Commission itself came the first suggestion that a mission of inquiry should visit the European countries to obtain first-hand information on their instrument requirements. The mission consisted of British and American personnel, and the report of the two British representatives, Mr. Thomas Martin, who was at the time of the mission deputy director of instrument production in the Ministry of Supply, and Mr. R. W. H. Cooke, of the Directorate of Medical Supplies, has recently been made available. It is a relief to learn from that report, largely written by Mr. Martin, that the task of rehabilitating the countries of Europe in respect to the scientific equipment of their educational establishments, although a very considerable one, is not so great as to be almost impossible of achievement in any reasonable period of time.

A digest by Mr. Martin of the report of the mission appears on p. 523 of this issue of *Nature*, and there would be little point in repeating facts and figures. Neither is it necessary to direct attention to the high desirability of the rapid and most complete restoration of scientific culture in Europe. It is proposed rather to deal with the implications of meeting this need of Europe for scientific instruments. It is apparent from the report that in the past Europe has, in general, looked to Germany for the supply of scientific equipment; and that, with one or two exceptions cited in the report, the activities of British instrument manufacturers were almost unknown on the Continent. It is, of course, common knowledge that Germany was, before the War, the chief country of the world for the production of scientific instruments. Without entering into the reasons for Germany occupying so predominant a position in respect to scientific instrument manufacture, or discussing the means adopted to maintain the position once it was established, it is relevant to remark that, while it would be most foolish not to admit that the average German scientific instrument was a most excellent product, there was much that was legendary in the very prevalent assumption of superiority of the German instrument over its British counterpart. It is assumed throughout the report of the mission that the European deficiency in scientific equipment would be met from British and American sources, and the exhibition of British scientific instruments recently held in Stockholm (see *Nature*, July 13, 1946, p. 66) gave a clear indication that in respect to quality the Continent was not being driven to use an inferior source of supply. Great Britain has lost much through the War, and it did appear to be a happy circumstance that the scientific instrument industry of the country, upon which the activities of scientific workers and the prosperity of industry are so largely dependent, would be considerably strengthened by the opening to it of European markets which had hitherto been largely closed.

It is therefore very disturbing to find, as is noted in the report, that the British instrument industry is still struggling with two main problems, shortage of skilled labour and inadequate factory accommodation. The shortage of skilled labour results largely from the disappearance during the war years of apprentices and improvers in the scientific instrument firms. This shortage is, of course, being felt in all branches of industry, but the impact on the instrument industry is felt in a peculiar measure, since the proportion of skilled labour in the industry is probably greater than in any other. The position is aggravated by the fact that the demands of compulsory military service make it difficult to remedy the deficiency. The productive capacity of the instrument industry was greatly enlarged during the War, and had the expansion in capacity been of a kind which could be readily maintained, it might have been that Great Britain's share in the re-equipment of European institutions for the teaching of science might have been carried out without undue difficulty. It happened, however, that the expansion of the instrument industry largely took place by the requisitioning of factories producing goods which were felt to be non-essential during the war period. These factories are now being de-requisitioned, and the instrument industry in Britain is now, in fact, a contracting one. In addition to the two main problems mentioned in the report, there is a third one, namely, the shortage of raw materials; and the dislocation in planned production resulting from uncertain delivery of raw materials not only limits the degree of production but also adds considerably to its cost.

The issue of the report, with its indication of a large requirement on the instrument industry of Great Britain for the provision of scientific instruments and apparatus in countries which formerly had other sources of supply, raises the question of the future state of the industry and of its ability to meet with smoothness the demands which will be made on it. These demands fall into three main categories. There is the provision of instruments for the teaching of science in the universities and technical institutions, and for the prosecution of research in those institutions and in other research establishments. It is probably true to say that, in the past, the man of science has not been very concerned as to where he obtained his instruments so long as he could obtain them; but there can be no question that, on the grounds of convenience and of certainty of supply in all circumstances, it is highly desirable that scientific workers in Britain should in general be equipped from British sources. In the second place, there is no greater factor in achieving high efficiency in industrial production than very complete instrumentation. For example, fuel economy can only be fully achieved through adequate instrumentation. In this competitive world, efficiency of production is essential and, therefore, in respect to an adequate export trade, inadequacy in the instrument industry may have alarming implications. Lastly the scientific instrument itself provides a mos economic article of export, since the cost of a scientific instrument rests not in the value of raw materials but almost entirely in the results of skilled labour If the industry finds difficulty in meeting the demands made upon it from the Continent of Europe, there must be foreboding as to its ability to play its vital part in the life of Great Britain in the future.

No one would wish to question the correctness of the urgency of priority given to such projects as housing; but it would be a pity, and in fact almost absurd, if the application of such priorities be made rigidly and automatically, thus preventing the instrument industry from receiving the necessary materials and facilities; for this industry must provide essential equipment required to enable science to play its full part in the rehabilitation of every phase of the national life. Indeed, the achievement of priority projects themselves may be delayed through the producing industries being denied any one of the prime means of working at full efficiency. There are implications in this report upon the needs of European countries for scientific instruments and laboratory equipment, which provide grounds for serious thought as to whether adequate consideration has been given to the maintenance of an instrument industry in Great Britain capable of meeting every demand made upon it; and whether, as stated in the preamble to the report, it is not unreasonable to ask that special consideration should be given to the post-war problems of this small but vital industry.

FIBRE PHYSICS

Contribution to the Physics of Cellulose Fibres

A Study in Sorption, Density, Refractive Power and Orientation. By P. H. Hermans. (Monographs on the Progress of Research in Holland during the War, No. 3.) Pp. xvi + 224. (Amsterdam, Brussels, London and New York: Elsevier Publishing Co. Inc., 1946.) 3.50 dollars.

THE trend of fibre research to-day is towards a clearer understanding of the parts played by the crystalline and non-crystalline fractions in determining the properties of the fibre, and this is the theme of Dr. Hermans' monograph. It may be said at once that he has chosen to consider, perhaps wisely as a beginning, those phenomena for which the properties of the fibre may reasonably be supposed to be additive with respect to the behaviour of the two fractions. The physical ideas on which he bases his discussions are of the simplest kind, and even if one feels that he sometimes tends to over-simplification, one cannot but admire his astonishing faculty of getting the most out of such elementary postulates.

At the outset Hermans admits that the partition of the fibre into two fractions is by no means absolute; as a working hypothesis, however, he interprets the term 'crystalline' in the strict sense, as giving rise to coherent diffraction of X-rays. Those cellulose chains, or parts of chains (he rejects the micellar theory in favour of the network), which are not included in the crystalline regions are assumed to combine statistically to give an average behaviour which as a first approximation is independent of the source and modification of the fibres. This dichotomy is, however, to be regarded as schematic, and is justified only if it provides a reasonable interpretation of the experimental results.

Hermans' ideas on water adsorption are best explained with reference to fibres containing 'Cellulose II', that is, regenerated and mercerized fibres. Having established the fact that the lattice dimensions of crystalline Cellulose II change with the water-content ('regain') of the fibre, he associates this with the formation of a hydrate (I) with a water content of 3·7 per cent. This hydrate is also formed in the 'amorphous' fraction, but here a second hydrate (II) (14·8 per cent water) is possible as well. The idea of hydrate II is based on the X-ray result that under suitable conditions a third cellulose modification—the so-called 'water-cellulose'—is possible. A relatively simple picture of the 'chemically bound' water is obtained in this way; it carries the adsorption isotherms up to a relative humidity of about 65 per cent. Native cellulose differs from Cellulose II in that in it only the non-crystalline fraction takes part in the sorption; the mechanism of water uptake is, however, the same in this as in the corresponding fraction of Cellulose II.

Arguing from the remarkable similarity in the shapes of the isotherms for various kinds of cellulose fibres, it is claimed that the ratio of the regains of any two fibres at any humidity will also be the ratio of the non-crystalline percentages in the fibres; regenerated fibres are thus found to contain about twice the percentage of 'amorphous' material as native fibres, whereas mercerized cellulose lies almost exactly midway between these extremes. At the lowest regains two results are noteworthy: the values of the sorption ratios of regenerated fibres relative to cotton tend to rise above their mean values, as would be expected on account of the formation of hydrate I in the crystalline Cellulose II; and the differential heat of adsorption for dry viscose is the same as for cotton, which should be so if the initial water uptake is due to the formation of the same hydrate in both fibres.

The question as to what is the correct immersion medium to use in measuring the density of textile fibres is still, apparently, unsettled. Water, organic solvents, and helium have all in turn been advocated, and until recently Hermans belonged to a school which favoured a reversion to water; but now he has taken a further step in the second cycle and prefers the organic solvents. From his point of view these score in comparison with helium because they are more likely to give different densities for fibres containing different amounts of crystalline material; and his results do, in fact, show that there is a close inverse relation between dry fibre density and sorptive power (which, of course, he has already linked up with the 'amorphous' percentage). The well-known rise in the density at low regains, formerly attributed to an increase in the density of the adsorbed water, Hermans explains simply as a geometrical packing effect of the water molecules fitting into inter-chain spaces in the non-crystalline fraction. This idea receives some support from the observed negative correlation between the dry density and the apparent density in water of regenerated and mercerized fibres; but native fibres do not fit into the scheme at all well, and Hermans concludes that it is not yet possible to give a quantitative interpretation of the observed densities in water for all cellulose fibres.

In the chapter on the optics of cellulose fibres much use is made of Gladstone and Dale's rule, which is shown to be of wide validity if applied to the *mean* refractive index of dry fibres. It is also the basis of a simple theory giving a very good quantitative interpretation of the optics of moist fibres. This assumes the additivity of the polarizations of the cellulose and water, a simplification which seems to give good results but which may not appeal to all readers. In the section devoted to the effect of orientation on the refraction one feels that had more consideration been given to other native fibres than ramie, and in particular to cotton, the sense of anticlimax engendered by Hermans' final admission that native and regenerated fibres cannot be included in the same simple scheme would have been avoided.

The last chapter is devoted to crystallite orientation, and here we may only note that as a result of his analysis of the 'optical' and 'crystallographic' orientation factors Hermans is able to set a limit, not as yet very accurately, to the value of the 'crystalline/amorphous' ratio. In regenerated fibres not more than one third of the fibre substance can be crystalline.

No mention of Hermans' work would be complete without a reference to his admirable experimental techniques, which are described in considerable detail in a series of appendixes. Altogether we must congratulate Hermans on his stimulating account of these researches carried out under conditions which at best could not have been very encouraging.

H. J. Woods

MAMMALIAN REPRODUCTION

Patterns of Mammalian Reproduction

By Prof. S. A. Asdell. Pp. xiii + 437 + 12 plates. (Ithaca, N.Y.: Comstock Publishing Co., Inc.; London: Constable and Co., Ltd., 1946.) 5 dollars; 27*s.* 6*d.* net.

REPRODUCTION is a branch of biology in which the methods of the naturalist and the anatomist have contributed considerably to an understanding of basic physiological processes. The comparative study of breeding seasons has given valuable clues to environmental and other factors which condition their variation. Differences in the characteristics of the œstrous cycle, and in the manner of ovulation, have directed attention to mechanisms that underlie the overt anatomical and behavioural changes in the reproductive rhythm. In its turn, anatomical and embryological study has provided useful indications for the experimental elucidation of such problems as the differential sensitivity of tissues to hormone stimulation. To-day, however, the broad zoological basis of the subject sometimes tends to become obscured by the more rapidly growing biochemical and physiological literature, and there is a danger lest a declining interest in systematic zoological study robs endocrinology of some potential points of advance.

The value of the comparative approach to the study of reproduction is admirably brought out in Prof. Asdell's "Patterns of Mammalian Reproduction". In it he has assembled, from the literature of natural history, zoology and physiology, such information as is worth recording about the sexual physiology of mammals. About two hundred species are dealt with in the text, while information relating to some seven hundred more is pulled together in the form of tables. The domestic mammals, and those most commonly used in laboratory work, are treated in detail. In the case of the rat, for example, Prof. Asdell has in effect produced a review of practically all that is known about the reproductive physiology of the species—including a detailed statement about the histology of the reproductive organs; it runs to some twenty pages and has a separate bibliography of 150 titles. In the case of such lesser-studied mammals as the African buffalo or the flying squirrel a paragraph or two summarizes what is known about the normal mating and breeding seasons, and about any special characteristics of the reproductive system. The tabulated material gives such information as exists about breeding season, number of young and duration of gestation in the species about which least is known. All this material is preceded by an introductory chapter which provides a general summary of such matters as sex-determination and differentiation; the hormones concerned in reproduction; the underlying pattern of, and changes in, the œstrous cycle of the reproductive organs; and pregnancy.

Prof. Asdell does not tell the reader which scheme of zoological nomenclature he has followed in his path through the Mammalia, and he provides few alternative systematic names. Little difficulty should, however, be experienced on this score by English readers with access to a modern systematic list of the kind issued by the Zoological Society of London.

In selecting his sources Prof. Asdell has wisely concentrated on the most important studies of each species, and particularly on those which emphasize the quantitative aspects of the subject. It is not improbable, as he suggests, that here and there specialists may find omissions in his record. Whether or not they do, no student of reproduction can afford to do without his new book. This will undoubtedly be the reward for what must have been a great labour of compilation, and one which, happily, helps to bring up to date the opening chapters of Dr. F. H. A. Marshall's classical study of the "Physiology of Reproduction", the last edition of which appeared in 1922.

S. Zuckerman

NATURE CONSERVATION IN THE BELGIAN CONGO

Animaux protégés au Congo Belge et dans le territoire sous mandat du Ruanda-Urundi

Par S. Frechkop, en collaboration avec G. F. de Witte, J.-P. Harroy et E. Hubert. Pp. xxi+469. (Bruxelles: Institut des Parcs nationaux du Congo Belge, 1941.)

THIS work is the second edition of what is in effect a guide to the protected mammals and birds of Africa, as well as a handbook of Nature preservation in the Belgian Congo. More than two hundred pages of it are taken up, often with considerable waste of space, by the proclamations, laws and local by-laws which govern field sports, Nature conservation and national parks in Belgian territory. The remaining three hundred pages constitute a guide to the protected species of mammals and birds (and one fish), designed to provide the traveller and sportsman with a means of identification; together with brief notes on distribution, habitat and habits. Much detailed and more technical information, such as particulars of sub-species and local forms, is appended in a valuable series of footnotes. The book displays a curious formality and inelasticity of treatment. Thus, dichotomous keys are provided throughout. Since practically all the species of large herbivores are protected, the keys concerned with these groups are distinctly useful. But, when we come to the birds, only a very small, seemingly haphazardly chosen, proportion of the total avifauna is preserved, so that the keys to this group are of relatively little value.

Each species is illustrated by pen drawings, often based on photographs or taken from published pictures or papers. Apart from some notable exceptions among the mammals, they tend to be wooden and harsh, and give the book an antiquated and rather stuffy air. Some good photographs and some attempts at an ecological approach, with pictures of types of habitat, would have considerably increased the usefulness, educational value and attractiveness of the volume. Whatever the subject, the scale of each illustration is given as a fraction of the natural size—leading to some quaint results. Thus, it is reasonable to be told that the drawing of, for example, a nightjar, is two-fifths natural size, but it is singularly useless and rather comic to see beneath an illustration of a charging bull elephant the words : "Environ 1/37 de la grandeur naturelle" !

There are many other minor points that might justifiably be criticized, but equally it would be unjust to lose sight of the great achievement in enlightened Nature preservation that the volume represents. British zoologists will indeed have reason for satisfaction when the British Colonial Office shows even a small part of the intelligent enterprise and enthusiasm for Nature conservation which has so long been manifest by the Belgian Government ; and when we realize that this volume bears the date '1941' it is not easy to find words to express our admiration. W. H. THORPE

ASTRONOMY AND HUMAN THOUGHT

The Stars and the Mind

A Study of the Impact of Astronomical Development on Human Thought. By Dr. Martin Davidson. Pp. x+210+8 plates. (London : Watts and Co., Ltd., 1947.) 10*s*. 6*d*. net.

IN this book the author discusses the effect of astronomical developments on human beliefs, and in addition gives an outline of the history of the science from the earliest times to the present day. The latter occupies about two thirds of the work and constitutes a valuable and comprehensive survey, illustrated by interesting plates and several diagrams.

In the opening chapters, an estimate is made of the worth of the Chinese, Chaldean and Egyptian contributions to astronomy. A short chapter on the uncertainty of the subject of Hindu astronomy is followed by a full appreciation of the Greek thinkers and their measurements, including the compendium known as Ptolemy's "Almagest". Throughout the historical survey, the impact of ideas on human beliefs is not overlooked, and in particular two chapters are devoted to Hebrew astronomy, including the origin of the Jewish week—a mystery which at present remains inexplicable. Special attention is given to the work of Copernicus, Tycho Brahe, Kepler and Galileo. The chapter on Newton concludes with a reference to deism. "From Newton to Recent Times" covers the period from the establishment of the Royal Observatory at Greenwich in 1675 to the work of modern cosmogonists.

The remainder of the book deals in some detail with the impact of astronomical developments on the Christian faith. The author finds it hard to agree with Dr. Barnes' contention that the progress of science has not forced us to admit any mistakes in Christ's views of God or of man's relation to God. Dr. Davidson directs attention to the influence that current Jewish ideas concerning the universe had on early Christian belief concerning the imminence of the end of the world, and advocates the recasting of all theological doctrines which rest on the geocentric theory of the universe. Modern astronomy has tended to modify views of 'the Fall', and the author examines at some length Canon Peter Green's work, "The Pre-Mundane Fall". Special attention is also given to "The Beginning and End of the World", by Sir Edmund Whittaker. In view of Whittaker's argument that the law of entropy involves a 'creation', Dr. Davidson devotes a complete chapter (17) to the "Second Law of Thermodynamics and the Beginning of the Universe", in which not only Whittaker's views are discussed, but also the principle of the conservation of angular momentum, especially in relation to Jeans' tidal theory ; and further, the question is raised as to how far the second law of thermodynamics has a universal application.

A short chapter on "The Expanding Universe" is followed by one on "How the Heat and Light of the Stars are maintained", and this includes some explanation of atomic structure.

In concluding his interesting book, Dr. Davidson urges the need "to adjust our view of the processes of the universe and of the place of human destiny to a new framework of knowledge". He claims that every religion, every philosophy is based ultimately on a conception of the cosmos, and his frank statements of the implications of astronomy concerning such conceptions should stimulate both philosopher and theologian in the task of relating their beliefs to the trend of modern scientific development.

H. D. ANTHONY

JEWISH PHYSICIANS AND MEN OF SCIENCE THROUGH HISTORY

Jewish Luminaries in Medical History

By Prof. Harry Friedenwald. And a Catalogue of Works bearing on the Subject of the Jews and Medicine from the Private Library of Harry Friedenwald. Pp. viii+199. (Baltimore, Md.: Johns Hopkins Press, 1946.) 3 dollars.

DR. HARRY FRIEDENWALD, professor emeritus of ophthalmology in the University of Maryland, has added to his two-volume work "The Jews and Medicine" (Baltimore, 1944 ; reviewed in *Nature*, **156**, 31 ; 1945) a third volume entitled "Jewish Luminaries in Medical History".

This volume, equal to the former publication in beauty and accomplishment of production, embodies an address containing new material on Donnolo, Maimonides, Amatus Lusitanus and others, down to Moritz Schiff and Paul Ehrlich. It refers to the wide contribution made by the Jewish medieval physicians to astronomy, notably to Mashallah (770–820), whose "Astrolabe" formed the source of Chaucer's treatise, to the Jewish physicians who were commissioned in the thirteenth century by King Alfonsus X to compile the "Alfonsine Tables", and to Zacutus the Elder, who, at the end of the fifteenth century, wrote his "Almanach", a copy of which was carried on his voyages by Columbus. An astrolabe made by Zacutus was put to practical use by Vasco da Gama. Bonet de Lattes, physician to several popes, published in 1493 a description of his astronomical ring-dial. Friedenwald's essay is followed by a catalogue of the author's unique collection of books bearing upon the subject of "The Jews and Medicine". The collection was started by his father in 1858 ; it consists of (*a*) the writings of individual physicians and publications concerning them, and (*b*) the more general works of reference.

The catalogue, replete with biographical and bibliographical detail, forms an indispensable source for the historian of science and medicine. W. PAGEL

Earth, Moon and Planets

By Fred L. Whipple. (Harvard Books on Astronomy.) Pp. vii+293. (London: J. and A. Churchill, Ltd., 1946.) 18*s*.

THIS is one of a series of books from Harvard Observatory, all of which are compiled by specialists in their own particular sphere. The present volume gives up-to-date information about the bodies in the solar system, and as it is written in language which is almost entirely free from technicalities, it will appeal to a wide circle of readers. The author devotes some space to a consideration of origins and evolution, especially to the origin of lunar craters and to the origin of the planetary system. He favours the volcanic theory of the formation of craters on the moon, but admits that meteors may be responsible for the more recent craters—those with ray systems and some of the whiter ones, and also for many of the craterlets and crater pits. In dealing with the origin and evolution of the planets in Chapter 14, he examines the arguments for and against the planetesimal hypothesis of Chamberlin and Moulton and the tidal theory, and gives his opinion in favour of a fairly rapid condensation as more probable than an accretion; but he admits that the choice between the two processes is not conclusive as the problems are complex.

A most valuable feature of the book is the planet finder and the star chart by means of which the positions of the planets can be located up to 1970. This portion will prove most helpful to many readers who want to know the positions of the planets from month to month.

The book is well illustrated by 140 figures, more than half of which are photographs.

Some minor corrections should be made in the next edition. It is usual now to accept the Astronomer Royal's recent determination of the solar parallax and to adopt 93,005,000 miles, not 92,870,000 miles (p. 3), as the astronomical unit. Although the 1931 approach of Eros is mentioned on p. 48, Hinks's value for the solar parallax is given. The extra motion of the perihelion of Mercury's orbit is more nearly 43″ per century than "about 50″" (p. 28). The velocity of escape from the solar system (presumably at the distance of an astronomical unit from the sun) is not 45 but 26 miles per second (p. 78). Further, meteors do not move with velocities of 45 miles per second relative to the sun (p. 78); this is their maximum velocity relative to the earth.

M. DAVIDSON

Statistical Analysis in Biology

By Dr. K. Mather. Second edition, revised and enlarged. Pp. iv + 268. (London: Methuen and Co. Ltd., 1946.) 16*s*. net.

THE profound effect which R. A. Fisher has had on the interpretation of biological data has been mediated through a book which most biologists can only dimly understand at first. The meanings of the new ideas put forward in this book are often not fully explained; but the interested reader is stimulated to think them out for himself. More detailed expositions of many of the new statistical methods are contained in various other books; but Dr. Mather's book is, so to speak, the authorized version. The author is primarily a biologist; but he has evidently devoted much thought to the meaning of the quantities that can be calculated from a set of data and their relation to one another. His book is illustrated with examples, and the reasoning is given at length so that much of it can be read fairly rapidly.

This book has been out of print for some time and the new edition will be welcomed. It is much the same as the first edition except that it contains a valuable new chapter dealing with two transformations which may be applied to percentages —$p = \sin^2\varphi$ and probits. In each case, the method is explained and one example is worked out.

The Bathe

An Ecstasy. By Marie Carmichael Stopes. Pp. iv + 19. (London: Alexander Moring, Ltd., 1946.) 5*s*.

OF the lyrical quality of this poem, as indeed of all Dr. Stopes' verse, there is no question. From the first apparently effortless stanza:

"Brown rocks have sucked in all the sun's warm rays
To over brimming, till they fill the air
To fine enraptured whirlpuffs gliding where
They quiver up the bank of sheltered bays",

continuing through the whole poem with the same musical consistency. Phrases slip into place with the same facility as their author appears to glide into the sea. Students of form would benefit by observing such unobtrusive craftsmanship.

"An Ecstasy" is no idle description; here is a spirit bubbling with almost youthful ebullience, whose flight is as spacious as it is melodic.

Individual lines are admirable:

"And lave my feet among these lambent pearls." "The swirl subsiding silence broods in me." "Deep clarity of blue translucence calls more than my body to be permeate."

But the author's enraptured journey tends to veil her powers of discretion. Imagination is not necessarily art.

"Soon my salt tanged palms
Vie with intoxicating scent brewed balms,
To yield sweet odours to the sun drenched sky.
Short golden hairs, minutest flagstaffs rear
Each on its tiny mound, but soon they cling
Content to nestle close like folded wing."

Avoiding this misguided sensuousness, Dr. Stopes would be a poet of quality, and a stronghold for readers who deplore the absence of buoyancy in modern poetry.

MARGARET HOWARD

Reports of the Progress of Applied Chemistry

Issued by the Society of Chemical Industry. Vol. 29, 1944. Pp. 574. (London: Society of Chemical Industry, 1946.)

THE present volume of this very useful review of the progress of industrial chemistry contains the usual sections. A notable feature is the inclusion of statistics in many cases where these had been held up during the war period. Those on coal make dismal reading. The abstracts are usually quite brief, so that it is scarcely possible to select any topics for special mention. Attention may perhaps be directed to some interesting information on moth-proofing (p. 91), on molecular weights of cellulosic materials (p. 101), plastics (p. 255), soils and fertilizers (p. 364), foods (p. 418), and fine chemicals and medicinal substances (p. 450). Many of these topics, it will be seen, are of general interest in various fields. The volume contains a very large amount of information and is well produced and indexed.

SCIENTIFIC EQUIPMENT IN EUROPE: PRESENT NEEDS

THE report has recently been issued* of a small Anglo-American mission which visited the devastated countries of Europe during the period February–June, 1946, for the purpose of finding out their needs of scientific instruments and laboratory equipment. This report has been prepared by the British members of the mission, and is based on a tour of twelve different countries. It has been made available by the Ministry of Supply for the information of those concerned, on the understanding that the opinions expressed and recommendations made are those of the authors and not of His Majesty's Government.

The countries visited, in the order named, were France, Switzerland, Italy (southern), Greece, Italy (northern), Austria, Czechoslovakia, Belgium, Holland, Denmark, Norway, Poland and Sweden. It had been intended to visit Jugoslavia, but this visit was reluctantly abandoned as the American members of the mission found it impossible to obtain visas at the time they were required. The two neutral countries, Sweden and Switzerland, were included in the tour because they are potential suppliers of some of the equipment, and also because their own needs cannot be disregarded in any assessment of European requirements.

The first suggestion of sending the mission arose at the meetings in London during the War of the Science Commission of the Conference of Allied Ministers of Education, of which the late Dr. E. F. Armstrong was chairman. Accurate information was required as to the conditions in the European countries at the end of the War. Moreover, it was considered that, in the immediate post-war period, the United States and Britain must necessarily be the principal sources of supply of the instruments and equipment needed for educational rehabilitation. The American and British Governments were therefore approached, and eventually the State Department nominated Mr. Wendell R. Turner of the Department of Commerce and Dr. James L. Thomas of the Bureau of Standards as the American representatives on the mission. The British Government appointed two officers of the Ministry of Supply, Mr. Thomas Martin, at that time deputy director of instrument production, and Mr. R. W. H. Cook. The mission was dispatched with the objects, first, of ascertaining as closely as possible the extent of the war losses of scientific instruments and laboratory equipment from universities, research laboratories and schools, and secondly, of bringing back as much information as possible as to the nature and extent of the rehabilitation requirements, to enable the instrument industries of Britain and the United States to make plans for meeting the demands. There was the incidental purpose of giving some lead to the industries of the two countries as to the export opportunities in this field, in view of the (at least temporary) elimination of Germany from the European market.

Much interesting information was obtained by the mission, and not the least valuable feature of the tour was the opportunity it afforded, soon after the end of the War, of comparing the conditions in the different countries. A separate section of the report is devoted to each country visited, and certain general considerations and conclusions in regard to the tour as a whole are set out in the introduction.

The report discloses extremely serious losses and shortages of equipment in many countries; but the opinion is expressed that there has been a tendency to exaggerate the extent of the losses as a whole. In one country, Poland, it would be difficult to exaggerate the extent of the destruction or the urgency of the need. Losses of equipment in Greece are scarcely less serious, but the problem of replacement is much smaller; while in Italy the destruction is very severe. On the other hand, certain countries actively engaged in the War have escaped relatively lightly as regards educational losses; for example, France and Norway. In all the countries, however, there are heavy arrears of normal requirements.

The value of the replacement requirements of the countries visited is estimated at not more than £18 million and not less than £14 million*. This total does not include Jugoslavia, and it was thought undesirable to include in the report any estimate for the two neutral countries, Sweden and Switzerland. Moreover, the estimates are in general based on 1939 values. When all allowances are made, however, the figure is still very much below estimates which were current before the mission left England.

Only a proportion of the total is likely to be called for from Britain and the United States in the immediate future. Some countries have considerable instrument-making resources of their own. In others there is uncertainty as to the extent of relief grants for educational rehabilitation, and as to the application of priorities in the utilization of funds or credits available. Shortage of foreign exchange is likely to limit overseas buying by most of the countries for a considerable time to come, and generally those with the greatest needs have the slenderest resources.

Intense interest in Anglo-American technical progress during the War, and a desire to fill the gaps in scientific knowledge caused by the cutting of communications during the German occupation, were everywhere manifest. In several countries sentiment was strongly in favour of obtaining scientific instruments and equipment from Britain and the United States and of breaking the previous German connexions in education and science. Resentment at German ill-treatment, for example in Holland, conduced strongly to this tendency. It must be said, however, that in the Scandinavian countries, and particularly in Norway, a different point of view was held. Many Norwegians wished to see German industry compelled to produce, and supply by way of reparations, the equipment urgently needed by the Allied countries. The dangers of a revival of the German instrument industry and of the virtual German monopoly of the Continental market were discounted or disregarded.

Whatever may be the opinions on this point, there can be no doubt that in Great Britain we have at the present time both a heavy responsibility and a remarkable opportunity in regard to the educational rehabilitation of Europe. It must be recognized, however, that in many countries very little is known of the resources of British instrument-making. There are notable exceptions: the instruments of one or two British firms are to be found in nearly every physics and chemistry laboratory in Europe; but the other makers are not well known to Continental users. In the case of survey instruments, for example, German and Swiss manufacturers have held the field so completely that the long-established and high-quality production in Great Britain is unknown. The position is very little better in regard to microscopes.

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* Report upon the Needs of European Countries for Scientific Instruments and Laboratory Equipment. Ministry of Supply (E2), October 1946.

* The estimate of £9 million mentioned in *Nature* of January 25, p. 110, referred to a report apparently made for the United Nations Educational, Scientific and Cultural Organisation. EDITORS.

Recommendations are made in the report with the view of correcting this state of affairs, particularly the setting up of more effective agencies for the British instrument industry in the principal cities of Europe. These should be well provided with instruments as well as literature, and have adequate servicing facilities; and it is suggested that a special study should be made of the commercial peculiarities and methods of ordering in the different countries. Reference is made to the very successful exhibition of British instruments held in Stockholm in May 1946, which was highly appreciated in Sweden; and the holding of further exhibitions in other countries is strongly advocated.

As to the nature of European requirements, the following passages are best quoted in full:

"It can be said with certainty that there is no type of scientific equipment which is not wanted somewhere in Europe; but we early found that it would not be practicable to bring back anything in the nature of detailed lists with quantities attached for each country. So varied are the needs and so dependent the ordering is likely to be on local conditions and personal preferences that such statistical information is generally not available in the countries themselves. Much miscellaneous information bearing on the needs of particular institutions is however given [in the separate reports for each country].

"Apart from this there are certain general shortages to which attention must be drawn. In nearly every country of Europe there is a serious, and in some cases an acute, shortage of laboratory glassware, that is to say, beakers, flasks, funnels and test tubes, particularly in the heat-resisting varieties, as well as graduated glassware, glass tubing and rod, and glass apparatus of all kinds. There is an equal shortage of laboratory porcelain, and of miscellaneous laboratory supplies—filter papers, rubber tubing, corks and the like. In many countries too, stocks of chemical reagents are long since exhausted, and further supplies, particularly of pure reagents, cannot be obtained. It is no exaggeration to say that in many parts of Europe the experimental teaching of chemistry is at a standstill because of these shortages of consumable laboratory supplies.

"As to direct war losses, heavy equipment, while it may have been damaged, for example by the stripping of non-ferrous metal components, has often been left and is repairable; but instruments of a portable character, such as microscopes, spectroscopes, lenses and photographic equipment, balances, galvanometers, resistances and small electrical instruments of all types, have everywhere been looted. Of all such instruments, large numbers are wanted in every country.

"Another serious shortage is of metal-to-glass equipment, that is, radio valves, X-ray tubes, cathode ray oscillographs, discharge lamps, rectifiers and so forth.

"Interest in war-time technical developments, particularly radar and atomic physics, will cause a demand for new equipment in many places. We saw cyclotrons in five different countries, and heard of others building. . . . High tension plant, Wilson chambers and their accessory equipment, hydrogen and helium liquefiers, compressors and vacuum pumps will all be wanted."

A shortage which was not strictly the concern of the mission, but which was everywhere apparent, was that of scientific and technical literature, particularly British and American text-books, journals and periodicals. In every university library the gaps in the shelves for the volumes from 1939 onwards were pointed out, and many of the professors regarded this as the most serious shortage of all. The problem of the back numbers and missing text-books is so serious and so important to science that a special and concerted effort is clearly needed to ensure the printing or re-printing of the missing books.

In the reports on the separate countries the visits to universities and institutions are described, and the conferences with government and other officials are summarized. In certain countries which have suffered heavy losses, among them Belgium, Holland and Czechoslovakia, the energy and initiative with which the problems of educational reconstruction are being tackled are most impressive. In other countries the circumstances are less satisfactory, and again the report may be quoted in full:

"In our report on Poland we have indicated that the destruction and loss to the educational system is so severe, and the resources seemingly so inadequate, that the problem becomes one of a different nature from that in some other countries. Elsewhere there are conditions which are almost, if not quite as serious. It would be impossible for any person of ordinary goodwill to see the state of the institutions we visited in Warsaw, in Athens and in Naples, without wishing that some way could be found to cut through the political and economic barriers which hold up action through the official channels, and bring some direct and immediate assistance to the courageous men and women who are struggling to carry on their work in these places. . . . There are in a few countries, and particularly in a few institutions within those countries, conditions so deplorable, and prospects of relief so remote, as to suggest that there are grounds for special action to relieve the most serious cases."

As to the part the British instrument industry may be able to take in dealing with this urgent problem, it is clear that greatly accelerated production of scientific instruments and laboratory equipment is needed to relieve the shortages in Europe. On commercial as well as humanitarian grounds the production is needed, for early delivery is the important consideration if the export possibilities are to be realized which the situation in Europe presents. Copies of the report have already been put at the disposal of the Council of the Scientific Instrument Manufacturers' Association of Great Britain, which is giving active and sympathetic consideration to its recommendations; but the industry is suffering from grave handicaps at the present time, among them inadequate factory space, shortage of skilled labour, and not least, difficulty in obtaining supplies of basic raw materials. It is much to be hoped that ways and means may be found of enabling this vital industry to continue, into the post-war years of reconstruction, the magnificent effort it made during the War.

THOMAS MARTIN

PEAT, HAY-FEVER AND PHARMACOGNOSY

By Dr. T. E. WALLIS

Curator of the Museum of the Pharmaceutical Society of Great Britain

THAT three subjects so diverse as peat, hay-fever and pharmacognosy should have a common meeting-ground of fundamental importance appears somewhat surprising. The common ground is found in the morphological study of pollen. Pollen grains were first studied in detail about 250 years ago by Nehemiah Grew. On plate 58 of his "Anatomy of Plants" he gives drawings of the pollen of eleven different plants. Grew referred to pollen as the "Particles of the Attire", the "Attire" being the andrœcium of the flower. He discusses the use of pollen, noting in Book 1 of his treatise that "it is for Ornament and Distinction to us and for Food to other Animals", while in Book 2 he refers to the uses previously discussed as being the "Secondary Uses" and proceeds to say "the Primary and chief Use of the Attire is such as has respect to the Plant itself" and "that the Attire doth serve, as the Male, for the generation of the Seed"[1]. It is clear, therefore, that Grew had a good understanding of the nature and functions of pollen.

During the subsequent two hundred years little advance was made, due principally to the inadequate microscopes in use at that time. However, by the beginning of the nineteenth century much improvement had been effected in microscopes, and the study of pollen was stimulated by the publication of books in which pollen from many plants was more adequately described than had been done previously. Chief among these were: (1) the well-known treatise of Hugo von Mohl, "Über den Bau und die Formen der Pollenkörner", Bern, 1834; (2) the "Micrographic Dictionary", London, 1856, by Griffith and Henfrey, in which there is a good article on pollen illustrated by excellent figures; and (3) a book containing drawings and descriptions of 450 pollens, entitled "Pollen", by M. P. Edgworth, London, 1877. These books and the increasing popularity of the microscope as a means of entertainment in polite society led to a greatly increased interest in pollen either as being objects of great beauty or as providing a means of identifying plants or families of plants (Fig. 1).

Pollen of Peat

Following upon this period, interest began to be taken in the origin of peat, both in Switzerland, where Früh (1885) published an article entitled "Critical Contribution to the Knowledge of Pollen in Peat", and also in Sweden, where Trybom (1888) noted how resistant pollen is to decay and suggested that pollen grains might serve as index fossils in palæontology. Systematic examination of pollen in peat began about 1916 when L. von Post wrote an article upon "Certain Bogs of Southern Sweden". At the present, pollen of peat deposits is regularly examined; the spores and pollen grains are counted and identified and their percentage proportions determined. From the results a good estimate can be made of the type of vegetation present when the peat was being formed, and the relative ages of neighbouring formations can be determined. Other geological problems also can be solved[2].

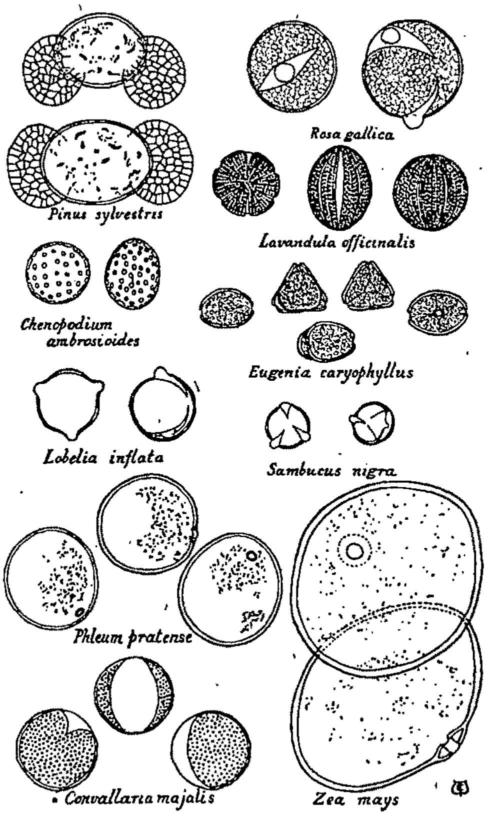


Fig. 1. POLLEN GRAINS FROM PLANTS OF ECONOMIC IMPORTANCE, SHOWING THE VARIETY OF SHAPE, SIZE AND MARKING. × c. 300

Hay-Fever

Three quarters of a century ago, C. Blackley, an English physician, living at Manchester, made experiments to discover the cause of hay-fever, and published his results in a thesis entitled "Experimental Researches on the Causes and Nature of Catarrhus Æstivus". He showed that susceptible persons quickly developed hay-fever when pollens of a large number of plants were applied to the (*a*) nares, (*b*) larynx, (*c*) conjunctivæ, (*d*) tongue and fauces. He also found that pollen of grasses was most potent, that of the common rye, *Secale cereale*, being especially toxic. He gave a list of fifteen families of plants the pollen of which produced hay-fever, and he found that in the month of June the number of air-borne pollen grains was at a maximum, 880 grains being collected on 1 sq. cm. of glass in one day[3].

From 1873 until 1916 this problem was allowed to remain as Blackley left it. In 1916, however, the investigation was revived with vigour in the United States by W. Scheppegrell, and since then it has been developed in that country by making systematic surveys of the atmospheric pollen in many of the States. The results have been collected and extended by Roger P. Wodehouse[4]. He has named a small number of families of plants, grouped in two sets, which he regards as particularly toxic in producing hay-fever; these are: (1) Herbs and Grasses—Gramineæ, Compositæ, Chenopodiaceæ, Amaranthaceæ, Plantaginaceæ, Polygonaceæ; (2) Trees and Shrubs—Betulaceæ, Fagaceæ, Ulmaceæ, Moraceæ, Juglandaceæ, Salicaceæ, Aceraceæ, Oleaceæ[5]. He concludes that the grasses possess the highest toxicity and that, since their toxicities seem to be of a similar type, it is necessary to use one pollen only for medicinal purposes, and timothy or cat's tail grass, *Phleum pratense*, is considered most suitable.

Pollen surveys were not made in Britain until quite recently, the first ones having been planned and executed at Llandough, near Cardiff, by Hyde and Williams in 1942 and 1944. Pollen was collected on microscope slides smeared with a thin coating of glycerin-jelly, and they were exposed in two ways: (1) in a horizontal plane, 'gravity slide'[6], upon which the pollen fell by gravitation from the atmosphere; and (2) in a vertical plane, kept constantly facing the wind, 'impact slide'[7]. The slides were exposed on the roof of the Llandough Hospital, supported on a stand about 12 in. above the roof-level, and were protected from rain, snow, etc., by a covering about 12 in. above them, stand and cover being about 3 ft. in diameter. At the end of the period of exposure (usually twenty-four hours) the slides were removed, a drop of glycerin-jelly applied and a cover-glass. The pollen grains under the cover-glass were identified and counted. The results were finally recorded in the form of graphs showing variations from day to day over a period of eleven months. The hours of bright sunshine for each day were recorded on the same graph so as to allow of correlation between sunshine and abundance of pollen. It was established that the effective pollen season extends from early March to late September, and that it shows three distinct phases dominated respectively by the pollen of (*a*) trees, (*b*) grasses, and (*c*) dicotyledonous herbs, the major part of the pollen being from anemophilous plants. It was also shown that periods of maximum numbers of pollen grains corresponded with periods of maximum sunshine.

For the modern treatment of hay-fever, an immunizing solution, known as a pollen-vaccine or allergen, is prepared from the pollen of *Phleum pratense* (Fig. 1) or from a mixture of pollens from a few selected grasses such as *Phleum pratense, Dactylis glomerata, Alopecurus pratensis, Anthoxanthum adoratum* and *Poa* spp.[8]. The collected pollen is extracted with ether to remove fatty matter; the residue is dried over calcium chloride or phosphorus pentoxide for several days and is stored until required. The allergen is made by macerating the prepared pollen in physiological saline, mixed with glycerin and phenol or in a special medium composed of sodium chloride 0·5 per cent, sodium bicarbonate 0·275 per cent, phenol 0·4 per cent, and water to 100[9]. The maceration is continued for about eighteen hours in a refrigerator, after which the macerate is filtered off, passed through a Seitz filter pad into a sterile filtering flask, from which it is transferred to sterile bottles for storage. When required for treatment the allergen is filled out into small sterile rubber-capped vaccine bottles. At least three different standards are used for the allergen solutions, the units being (1) representing the extract from 0·001 mgm. of pollen, equivalent to about 80–100 pollen grains and known as a Noon unit; (2) equivalent to 0·00001 mgm. of nitrogen precipitable by phosphotungstic acid; (3) equivalent to 0·02 mgm. total nitrogen per mil. The treatment extends over about three months prior to the pollen-distribution period, the allergen solution being injected subcutaneously, beginning with very small doses and ending with 5,000–10,000 units[10]. Repetition of the treatment for three years in succession is generally necessary for immunization.

Pharmacognosy

Pollen grains are used in the science of pharmacognosy as an aid to the identification of drugs and spices, more especially for determining the sources of different kinds of honey and for the identification of powdered drugs such as cloves and belladonna herb. For all these purposes, the morphology of the pollen grains must be studied and records made of diagnostic characters, such as (1) dimensions and shape, (2) surface characters of the exine, (3) presence or absence of pores and germinal furrows, (4) contents, such as fixed oil and small starch granules[11]. Using these features, pollen grains may be grouped upon a plan such as the following:

(1) No furrows and (*a*) no pores, for example, gymnosperms and *Crocus sativus*; (*b*) one pore, for example, grasses; (*c*) two pores, for example, *Colchicum*; (*d*) numerous pores, for example, *Chenopodium*.

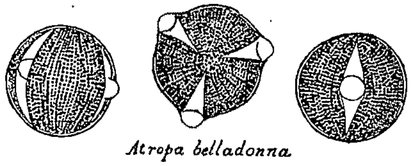
(2) One furrow, no pores, for example, *Convallaria* and many other monocotyledons.

(3) Three furrows and three pores, for example, most dicotyledons.

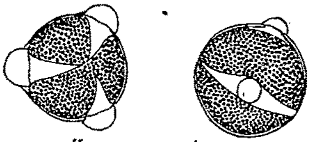
(4) Six furrows and six pores, for example, lavender and many other Labiates.

The mountant for the pollen is important because the shape and size depend upon its action. The two most useful mountants are solution of chloral hydrate (five of chloral hydrate in two of water) and lactophenol[12,13], both of which affect the pollen in approximately the same way. Chloral is used because it is the mountant in which powdered vegetable materials are most commonly examined; lactophenol is useful because it rapidly penetrates among small particles, thus avoiding heating to remove air-bubbles, and does not evaporate. Permanent mounts are generally made by removing excess of the fluid mountant and substituting glycerin-jelly.

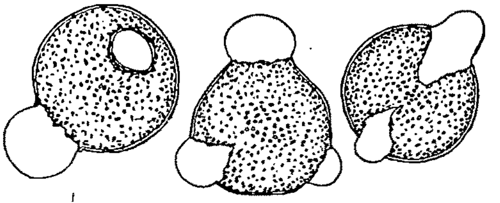
For the purpose of judging the quality and source of honey, pollen has been systematically studied in Germany by Prof. Enoch Zander, who has published



Atropa belladonna



Hyoscyamus niger



Datura stramonium

Fig. 2. POLLEN GRAINS FROM PLANTS OF THE FAMILY SOLANACEÆ. × *c*. 300

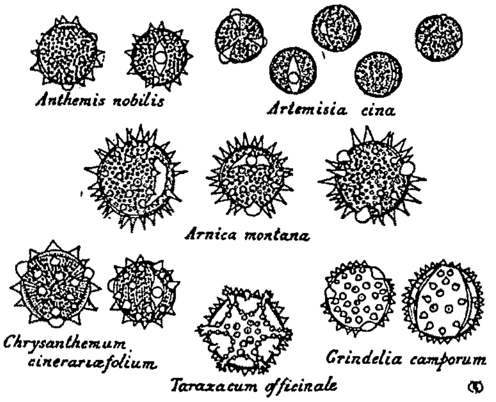


Fig. 3. POLLEN GRAINS FROM PLANTS OF THE FAMILY COMPOSITÆ. × c. 300

descriptions, including measurements, of a large number of pollens, with eighty plates of excellent photomicrographs of some 750 different kinds[13]. The pollen is separated by mixing the honey with water and centrifuging, after which the pollen is mounted in glycerin-jelly. The pollen grains are then identified and counted and a percentage table is constructed; from this a conclusion may be made as to the source of the honey[15].

Although the dimensions of pollen grains are important characters, it is probable that the shapes and markings are more reliable criteria for diagnosis. These facts are immediately evident when one examines the pollen from closely related plants. For example, pollens from the three common drugs belonging to the Solanaceæ (Fig. 2) have the following characters[14]: *Atropa belladonna*, sub-spherical, 37–50 μ in diameter, exine with lines of pits radiating from the poles, three furrows, three pores which are about 8 μ in diameter; *Hyoscyamus niger*, sub-spherical, 40–50 μ in diameter, exine with pits in a scattered arrangement, three furrows, three pores which are about 15 μ in diameter; *Datura stramonium*, sub-spherical, 56–80 μ in diameter, exine coarsely granular, no furrows, three pores which are 15–24 μ in diameter.

Similarly with pollen of compositous plants, the important distinguishing features are the presence or absence of cuticular spines, the length and number of the spines when present, the arrangement of any ridges as in *Taraxacum officinale* and other plants of the Cichorieæ (Fig. 3, and the accompanying table[14]):

Name	Shape	Diameter	Surface	Furrows	Pores	Notes
Artemisia cina	Sub-spherical	20 to 25 μ	Finely granular	3	3	No spines
Grindelia camporum	Sub-spherical	32 to 45 μ	Smooth; spines 2 μ long	3	3	21 spines in the disk
Arnica montana	Sub-spherical	40 to 52 μ	Very finely granular; spines 8 μ long	3	3	16 to 18 spines in the disk
Anthemis nobilis	Sub-spherical	30 to 36 μ	Finely warty; spines 3 μ long	3	3	12 to 13 spines in the disk
Chrysanthemum cinerariæfolium	Sub-spherical	34 to 40 μ	Lines of warts radiating from the poles; spines 4 μ long	3	3	10 to 11 spines in the disk
Taraxacum officinale	Hexagonal-spherical	32 to 40μ	Smooth spines 2 μ long	0	3	40 spines in the disk, etc.

The spores of *Lycopodium clavatum*, which are used as a dusting powder, as a vehicle for snuffs or insufflations of penicillin and menthol and also in large quantities in pyrotechnics, have an important use in microscopy to enable one to estimate the weights of materials seen in the field of the microscope[16]. The determinations depend upon counting methods based upon the number of lycopodium spores per mgm., which is 94,000[17]. This process is possible because lycopodium spores are very uniform in size, easily identified by their shape and markings and are highly resistant to most common mountants and microscopical reagents.

The study of pollen and spores has therefore yielded details of great economic importance. In addition to the elucidation of academic problems, the study has proved of much value to the advance of medicine and to the analyses of peat, honey, drugs, spices and foods, thus providing the foundation for much knowledge of such diverse subjects as peat, hay-fever and pharmacognosy.

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PROGRESS OF CANCER RESEARCH

By Dr. I. HIEGER

Chester Beatty Research Institute, Royal Cancer Hospital (Free), London

THE British Empire Cancer Campaign has awarded the Garton Medal and Prize of £500 to Prof. E. L. Kennaway in recognition of his outstanding contributions to cancer research. Eighteen years after his discovery of the first carcinogenic hydrocarbon (1 : 2 : 5 : 6-dibenzanthracene), investigators are still synthesizing and testing new carcinogenic compounds although these now number more than three hundred; and in fact studies of carcinogens and their mode of action form the largest single group of investigations in progress in the twenty-one centres of research financed, assisted and co-ordinated by the Campaign.

In the accompanying table, the reviewer has attempted a classification of the investigations described in the twenty-third annual report issued by the Campaign approximately according to their numerical occurrence, but of course this arrangement is no conclusive proof of priority in any sense. Numerous modifying factors should be taken into account in any more precise evaluation. For example, some of the reports of researches are detailed, some highly summarized; some pursued by a single worker, others by a team; one may represent a project barely begun, another may be one of those long-term investigations which can only give results after several years and where, consequently, one year's report reads much the same as that of the previous year; and finally, the type of research which can take advantage of the fertile technique of organic chemistry is bound to attract more attention than others which depend upon less well-developed techniques. Nevertheless, it is obvious that carcinogenesis by chemical compounds, work on X-rays and radium, and chemotherapy form the largest three groups of investigation.

Carcinogens, their mode of action, factors affecting carcinogenesis, metabolites, carcinogenesis by tar and petroleum	15
Radiology, developments in the use of X-rays and radium, action of radiation on tissues and tissue constituents. Biophysics, use of radioactive isotopes	14
Chemotherapy by stilbene derivatives, œstrogens, urethane and other compounds	7
Filterable tumours	5
Cytology	3
In vitro culture	2
Nucleoproteins	2
Histology	1
Social distribution of cancer	1
Genetics	1
Enzymes	1
Transmissible milk factor for mammary cancer in the mouse	1

Apart from laboratory experiments, much clinical investigation has been pursued at practically all centres, and the Clinical Cancer Research Committee presents an elaborate report of nearly 1,500 cases of cancer of the rectum and anus treated statistically under thirty-five different headings dealing with the pathological, surgical and etiological aspects. Three new projects are being launched by the Campaign this year.

At Edinburgh, a pool of experimental animals is being bred, and transplantable tumours are being kept growing in animals for use by other research centres, much like the national collection of type cultures. The Campaign is producing a new journal, the *British Journal of Cancer*, and virus research in relation to cancer is to receive stimulation by a £25,000 grant, which will no doubt also accelerate experimental work with filterable tumours and in related fields such as the transmissible milk factor for mouse carcinoma, nucleoproteins, and ultra-violet microscopy.

Among the latest carcinogenic compounds to be tested at the Oxford centre are some containing sulphur; for example, 4 : 9-dimethyl-2 : 3 : 5 : 6-dibenzthiophanthrene and 4 : 7-dimethyl-2 : 3 : 5 : 6-dibenzthionaphthene. Such sulphur-containing carcinogens are no doubt already being used in tracer experiments where radioactive sulphur forms part of the molecule. At the same centre, species differences have been sought in experiments where 9 : 10-dimethyl-1 : 2-benzanthracene—to date the most powerful carcinogenic agent known—was tested on mice, rats, rabbits and guinea pigs; but it might perhaps be objected that instead of such sledge-hammer methods the test would have been more sensitive if a less active agent had been used. Some investigator with a sense of humour might try the effect of cancer-producing hydrocarbons upon the crustacean after which the disorder was named so long ago.

Bielschowsky at Sheffield is continuing experiments with one of the most remarkable carcinogens, 2-acetylaminofluorene, which when fed to rats and mice produces cancer in the liver, ductus acusticus, thyroid, blood cells, mammary gland, bladder, stomach and uterus. He has found that 2-aminoanthracene readily produces tumours of the skin in albino rats, and this compound must therefore be classed as one of the simplest carcinogens. The cellular structure of these skin tumours is usually different from that of skin tumours in mice produced by hydrocarbons, and hence different processes must be involved in carcinogenesis by the two types of agent.

Many workers in this field—probably a majority—incline to the theory that the carcinogen, before it can effect neoplasia, has first to be converted by the tissues to an active derivative, which is the true carcinogen. Proof of this theory is, however, somewhat unconvincing as yet. Indeed, what evidence is available points rather in the opposite direction, since metabolic products of the carcinogens have so far shown very little carcinogenic activity. A metabolite of 2-acetylaminofluorene isolated from rat urine, namely, 2-acetylamino-7-hydroxyfluorene, has so far proved inactive as a carcinogen; the metabolite of 3 : 4-benzpyrene, namely, 8-hydroxy-3 : 4-benzpyrene, is only very weakly carcinogenic, but if the hydroxyl group is converted to methoxy, the new compound is then strongly carcinogenic. It must be noted that to speak, as some do, of 'methylated metabolite' conveys a little ambiguity, because the methylation takes place in the test-tube, but the metabolite is generated *in vivo*. Moreover, Dickens has tested the carcinogenity of the 'methylated metabolite' from 9 : 10-dimethyl-1 : 2-benzanthracene and finds it (4′-methoxy-9 : 10-dimethyl-1 : 2-benzanthracene) inactive.

At Glasgow, Peacock and his colleagues have, among much other work, extended the study of co-carcinogens to gastric cancer. By adding one of these substances, croton oil, to the diet of rats, hyperkeratosis of the stomach, but not cancer, was produced; and even if a weak carcinogen were added to a diet containing an irritant (pepper), tumours were not found at post-mortem. No mention is made of results with a combination of croton oil and weak carcinogen added to the diet, but perhaps such tests are already in progress.

At Leeds, Orr has found that when methylcholanthrene is applied to the skin of mice of the *IF* strain (highly susceptible to skin cancer induced by hydrocarbons, but not liable to spontaneous mammary cancer), cancer of the mamma and pulmonary adenomata were found in every experimental animal. Attempts were made to breed from these mice with induced mammary cancer, to see if the disease was transmissible, unfortunately without success. Work on somewhat similar lines is being pursued at Newcastle by Pybus and Miller, who are following up the extraordinarily interesting discoveries of Strong in the United States. Strong reported that the methylcholanthrene treatment of certain inbred strains of mice induced a greatly increased tendency to carcinoma, particularly of the stomach, which was transmitted to subsequent generations without any further application of the methylcholanthrene.

Advances in radiology have been on several lines, but chiefly in developments of the complicated, but immensely important, task of assessing the distribution of dosage of X-rays and γ-rays in the body of the patient in three dimensions. By means of small condenser chambers the dosage can now be measured directly in the patient during treatment, and studies are being made of the measurement of the integral dose and of the causes of X-ray sickness. Artificial radioactive substances such as radio-sodium and radio-phosphorus are being used for tracer element experiments and for radiotherapy. At the Strangeways Laboratory, Cambridge, the action of X-rays, γ-rays and α-rays have been studied in a large variety of materials ranging from inorganic substances, through *in vitro* culture of fibroblasts, to the normal brain of mice and rabbits.

At Leeds, Rudall has examined with X-rays the crystallographic structure of the proteins in the cells of the epidermis before and after cancerization, and finds that the proteins of papilloma tissues induced in rabbits by the Shope virus differ structurally from the proteins of normal skin.

The number of compounds which have been tested for chemotherapy in cancer must now run well into the thousands, and the present situation is that Haddow finds derivatives of 4-aminostilbene the most effective against transplantable tumours in rats; œstrogens are being used for prostatic human cancer and urethane for human leukæmia. It must be noted that all three compounds are also cancer-producing agents; for example, 4-dimethylaminostilbene evokes a wide variety of tumours in the rat, and urethane produces lung adenoma in mice. Œstrogens, while only weakly carcinogenic at the site of administration, produce uterine fibromata in the guinea pig (Lipschutz) and also facilitate cancer of numerous organs and tissues in mice of strains liable to spontaneous mammary cancer (W. U. Gardener). These findings reinforce Haddow's original theory that carcinogenicity and tumour-inhibitory capacity are closely linked properties of chemical compounds, somewhat in the same way that radiations in different dosages can either produce or inhibit the growth of tumours.

Koller has continued his cytological studies of the mechanism of radiotherapy and comes to the conclusion that the success of the treatment depends largely on the indirect action of the radiation, that is, upon the still healthy tissue forming the tumour bed, rather than a lethal action upon the tumour cells directly.

At the Cancer Research Laboratories of the Hebrew University, Jerusalem, detailed studies are being made of the malignant conversion of normal fibroblasts *in vitro* by the Rous agent, and on the cytology of the different strains of rat sarcomas *in vitro*, which present a great variety of structural peculiarities, although they were obtained by the same agent, namely, benzpyrene.

Prof. and Mrs. Kennaway, continuing their examination of that treasury of information, the Registrar-General's reports on the deaths in Great Britain, have extracted the facts that cancer of the scrotum is about twenty times less common in men of the highest social class than it is in the general population. Thus hygienic habits of cleanliness, and perhaps other conditions common in the wealthiest social strata, could, if spread over society in general, greatly diminish at least one form of cancer.

Cornelia Hoch-Ligeti has been confirming earlier results showing that milk added to the diet of rats receiving butter yellow (dimethylaminoazobenzene) gives considerable protection against the formation of liver tumours. It is therefore possible that dietary deficiencies may partly account for the widespread occurrence of liver cancer in the Japanese, Chinese, Indian and allied Asiatic races, and particularly the Bantus of South Africa, all of whom have been, until recently, less well nourished than Europeans.

Hieger, after ten years work on carcinogenic substances in human tissues (first discovered by Schabad in Leningrad), concludes that: (*a*) not only liver but also lung, kidney and muscle contain these substances; (*b*) human subjects that have died of cancer *or* of other diseases contain these agents; and (*c*) that they are to be found in the cholesterol-rich fraction of the tissues and are probably sterols or closely associated compounds.

OBITUARIES

Prof. F. Paschen

PROF. F. PASCHEN died in Potsdam on February 26; he was eighty-two years old. According to his daughter, the extreme cold at the time resulted in his contracting pneumonia, from which he failed to recover.

Paschen was a giant among spectroscopists, and with his passing there closes a chapter in classical spectroscopy which included such other names as those of Lockyer, Kayser and Fowler. It is difficult to realize that fifty-five years have passed since Paschen first began his classical work on the infra-red. Since then a veritable torrent of publication came from his pen, and only ceased with his death. He covered the whole of experimental spectroscopy in a masterly manner, making a succession of important discoveries. Infra-red measurements, precision wave-length determinations, analysis of series, interpretation of hyperfine structures, were all illuminated by him.

He developed the delicate Paschen galvanometer, discovered the Paschen infra-red series in hydrogen, was senior co-discoverer of the Paschen–Back effect in magneto-optics, invented the Paschen hollow cathode discharge and so on. His masterly analysis of the complicated series in the neon spectrum is a classic. Although the analysis of series in spectra was his major interest, yet he realized the value of the hollow cathode for hyperfine structure studies and did a great deal of work in this field too.

It was my good fortune to go to Berlin to study under Paschen in 1931, and he welcomed me as his first (and last) research student from England since 1914. My most vivid recollection is of a man with a dynamic virility, a freshness of mind and a generous nature. He had a profound understanding of most of the techniques of experimental spectroscopy, and it was an inspiration to see the energetic, impulsive manner in which he worked. His eyesight was unusually keen and he missed nothing. Withal he was an engaging *raconteur*, telling his amusing stories about physicists equally well in English and German. The Zeeman pictures he obtained will be surpassed only with difficulty, and he had a fund of knowledge on the use of high-resolution interferometers. He was essentially an exact experimenter, with little use either for gadgets or for those statistical methods which attempt to extract as much as possible out of observational data. In 1931 I showed him a trivial statistical trick I had developed. His smiling comment was: "If measurements on a plate are not self-consistent, smash the plate and take another. This is far better than statistics." A rash procedure possibly, yet typical of the man, whose first aim was self-consistency and internal checking in all he attempted. Yet he was bold and adventurous in interpretation, with a masterly grasp over complexity. He had a deep respect for A. Fowler, who went to the other extreme and was hesitating and cautious. Paschen admired this caution and once remarked: "Fowler has never yet made a mistake". He confided to me that independently and simultaneously with Fowler he had arrived at the important analysis of carbon and silicon which showed the existence of multiple ionization spectra. Fowler's classic paper on this appeared first, and Paschen considered it was so much better than his work that he tore up his own manuscript. This was typical, for Paschen was the last man to take even due credit for himself, and was scrupulously just in apportioning credit and priorities to others.

Until the advent of Hitler, Paschen was president of the Physikalisch Technische Reichsanstalt; in 1933 he was dismissed by the Nazis and replaced by Stark. He had made himself highly unpopular with the Nazis by persistently purchasing considerable costly spectroscopic equipment from England, maintaining that German makers could not equal the British products. After 1933 he was permitted to use a small room in the Reichsanstalt. He strongly disliked the Nazis and their methods; but possibly his age saved him. He wrote me an open denunciatory letter in 1936, which if intercepted must surely have led him to the concentration camp. Between 1933 and 1939 his time was largely devoted to measuring old plates, and a few papers were published. In 1943 he lost all his possessions in a fire raid, but although seventy-eight years of age still kept on working, and to the last was engaged on calculations.

He had many pupils and has trained a whole generation of spectroscopists who have much to thank him for, particularly in Germany and in the United States.

S. TOLANSKY

The Right Hon. Sir Halford Mackinder, P.C.

BORN at Gainsborough on February 15, 1861, Halford John Mackinder was the son of a medical practitioner and received his school education at Epsom College, whence he proceeded to Christ Church, Oxford, becoming president of the Oxford Union in 1883.

It is not clear what turned Mackinder's attention in his student days to geography, which was then a subject unknown in the universities and despised by schools, but it was almost immediately after graduation that he planned a series of lectures under the title of "The New Geography" for the Oxford University Extension Lectures. His ideas he crystallized into a paper on "The Scope and Methods of Geography" which he read before the Royal Geographical Society in 1887. It was through the interest created in the Council of the Society that the University of Oxford appointed Mackinder in the same year to a readership in geography, the only previous holder of such a post having been Richard Hakluyt in the reign of Queen Elizabeth.

Although called to the Bar in 1886, Mackinder devoted himself to university work. He became a Student of Christ Church, Oxford, in 1892, and in the same year was appointed principal of University College, Reading, now the University of Reading.

While holding those posts he became president in 1895 of Section E (Geography) of the British Association for the Advancement of Science, and put forward a powerful plea for the formation of a university institute of geography, where might be brought together what we now call 'physical' and 'human' geography on the same platform. It is again to the credit of the University of Oxford that the School of Geography there was created in 1899.

Mackinder lived to see his great aims for the university teaching of modern geography realized by the creation of honours schools in nearly all the universities of Great Britain, and there is no doubt that the part he himself played was an extremely important one.

Although he continued as reader in geography at Oxford until 1905, in 1903 he left Reading to become director of the London School of Economics and Political Science. The School was then only eight years old, and Mackinder succeeded Prof. W. A. S. Hewins. It is well known that the School was founded by a group of Socialists headed by Mr. and Mrs. Sidney Webb and Bernard Shaw; but its founders realized the danger of allowing party political views to dominate the activities of a young institution the sphere of work of which was, and is, a dispassionate academic study of economics, politics and the social sciences generally. Mackinder was already known for his Liberal–Unionist political views (he had contested Warwick as a Liberal in 1900), and his choice as director of the School supplied a valuable balancing influence and removed once and for all what might have been a real danger.

In 1909, at the age of forty-eight, Mackinder entered his political career by standing as Unionist candidate for Hawick Burghs. Though not successful in this attempt, in the following year he was elected for the Camlachie Division of Glasgow, a seat which he retained until 1922. He relinquished his post as director of the London School of Economics in 1908 but remained as reader in geography at the School (a post he had held part-time since 1900), later as professor, until 1925, serving under Pember Reeves and Sir William (now Lord) Beveridge as successive directors.

In 1920 Mackinder took charge of a special temporary mission as British High Commissioner for South Russia, at the completion of which he was knighted. After his retirement from academic work he served as a member of the Royal Commission on Food Prices in 1925, and in the following year was made a Privy Councillor, and became chairman of the Imperial Economic Committee. He was already chairman of the Imperial Shipping Committee, a post which he held from 1920, the year of its formation, until 1945.

It is difficult to assess the whole influence of Mackinder on the development of geographical thought. Although what he initiated and taught at Oxford, Reading and London has become absorbed as an essential part of geography as it is now studied throughout the universities of Britain, his ideas were often so in advance of those of his political contemporaries that they are only now coming to be appreciated. His most famous work, "Britain and the British Seas", appeared in 1902. It is rightly described as a classic. For the first time it related the physical features of our own familiar land with the sequence of human occupation and development and with our economic interests. In lucidity of language which is used to clothe the thoughts of a clear and brilliant brain, it has never been surpassed. His masterly analysis of the factors of position is only now being appreciated in connexion with the development of world airways; his concept of regional contrasts, especially between Highland Britain and Lowland Britain, or between Metropolitan England and rural areas, is only now being recognized by the development of physical planning on a regional basis so that contrasts in needs and aims can receive adequate consideration in practice. The problems of Highland Scotland, to take an extreme example, are difficult of comprehension in Metropolitan England. Mackinder made free use of diagrammatic maps or cartograms, on which selected facts only are represented, to drive home his points—this is an art well known to geographers but still relatively unfamiliar to the public.

His deservedly popular lectures exercised a great influence on the many thousands of students who crowded to hear him. Though delivered without notes, they showed his dislike of slipshod work: they were balanced, closely reasoned and inevitably closely allied to the series of sketch maps which always adorned the walls when he was lecturing.

Although he worked steadily among his parliamentary colleagues to secure an appreciation of geographical analysis, he was still in advance of his time when he published "Democratic Ideals and Reality" in 1919. It aroused interest, but not enough; and it was left to the Nazis to prostitute geography to their ideology in the school of Geopolitik. It was only during the Second World War that this remarkable work of Mackinder's began to be appreciated. The original edition was still in print when the book was re-issued in a popular form. Most great problems of the day need analysis from economic, political, sociological, historical and geographical points of view: too often wrong conclusions are reached through the neglect of one of these points of view, and the most neglected approach is still that of the geographical. In this sense Mackinder's work has still to bear its full fruit. His outstanding contributions to geographical thought were recognized towards the close of his long life by the highest award the Royal Geographical Society has power to bestow—the Patron's Medal; and the highest award of the American Geographical Society, the Charles P. Daly Medal, was presented to him in 1944.

It is not widely known that Sir Halford was a mountaineer of the first calibre. In 1899, with the help of two Swiss guides, he was the first to ascend Mount Kenya, and it was thirty years before another climber succeeded in making what is still regarded as a very difficult ascent.

He retained his brilliant intellect until the end, inconvenienced only by increasing deafness, and only a few months before his death on March 6, 1947, he had visited his old Department at the School of Economics and discussed problems with his former colleagues and students. L. DUDLEY STAMP

Sir Ali Ibrahim Pasha, K.B.E.

THE death of Sir Ali Ibrahim Pasha, of Cairo, removes the greatest personality in the medical profession of the Middle East. Sir Ali's career was a model of what perseverance and study can do.

Born in 1880, he graduated from the Cairo School of Medicine in 1901. After holding a house appointment in the famous Kasr el Aini Hospital of Cairo, he began his career as a young assistant surgeon in the provincial hospitals of Upper Egypt. Within a few years his skill as a surgeon, his personality as a humane doctor and a very pleasant colleague made his name popular and well known in many Mudiriahs of Upper Egypt.

He was then recalled (in 1907) to take up an appointment as assistant surgeon at his old hospital, the Kasr el Aini. Again his charming personality, his diagnostic acumen and surgical skill soon made him the recognized surgeon in Cairo and later in the whole of Egypt.

He became dean of the Faculty of Medicine in 1928, and took an active part in the reorganisation of medical teaching, and in the draughting and execution of a huge programme of construction and equipment of the Departments of the Faculty and the teaching hospitals. In fact, his term of office as dean from 1928 until 1940 may be considered a period of renaissance in the history of medical education in Egypt.

Ali Pasha's activities extended far beyond the boundaries of a Faculty. He instituted and organised the Royal Egyptian Medical Association on the lines of the British Medical Association. That Association now has an imposing building of its own in Cairo, with a big ceremonial hall, a library, a museum, and it issues a medical journal.

Ali Pasha was an active member and later president of the Egyptian Red Cross Society.

He was instrumental in his short career as Minister of Health in passing through Parliament a Bill creating a Syndicate of the Medical Profession to look after the interests of the profession and to provide funds for an insurance scheme.

During the last six years Ali Pasha was rector of the Fouad I University of Cairo, when his constructive genius was again most productive and his powers of organisation were most evident.

His death at the age of sixty-six was certainly a great loss to the medical profession and to the whole of Egypt. I. S.

Major M. Connolly

MATTHEW WILLIAM KEMBLE CONNOLLY was born in Bath on February 13, 1872, the son of Vice-Admiral Matthew Connolly, R.N., and Harriet Connolly, *née* Kemble. He was educated at Haileybury and Sandhurst, and for some years led the life of the Army officer of his period. He married Muriel Vernon, of Clontarf Castle, Dublin, who, with their one son, survives him.

After retiring from the Army, Major Connolly became an unofficial scientific worker in the Department of Zoology of the British Museum. He was especially interested in the Mollusca, particularly the land and freshwater molluscs of Africa, of which he had profound knowledge and on which he was the leading authority. Many papers on this subject were published from 1910 onwards: the most important was, undoubtedly, "A Monographic Survey of South African Non-marine Mollusca" (*Ann. S. Africa Mus.*, **33**, 1–660, pls. 1–19; 1939).

In later life Connolly was badly crippled by arthritis and could walk only with difficulty. Despite this handicap, he insisted on doing everything himself; indeed, I had known him for more than twenty years before he would let me walk across Cromwell Road with him, and even then only because the fog was thick and the crossing more than usually dangerous. Inside the Museum he went from room to room, and from library to library with cheerful good humour.

Connolly joined the Malacological Society of London in 1908. Five years later, in 1913, he joined the Conchological Society, becoming its president for the session 1929–30; at the time of his death he was a vice-president. He was no narrow-minded specialist; his interests were wide, his knowledge of cookery and wines extensive. He remained in London for most, if not all, of the war years, and was among the survivors when his hotel was largely destroyed by a flying bomb. That incident affected him more than he cared to admit: soon after the end of hostilities, he began to wind up his affairs in London in order to retire to Bath. This last plan was never realized; he died in South Kensington on February 26, 1947, and is buried in the family vault at Bath.

A. T. Hopwood

NEWS and VIEWS

Sir Roy Robinson, O.B.E.

It has been announced that Sir Roy Robinson will shortly relinquish his appointment as director-general of forestry. This will not, of course, mean that he is severing his official connexion with the forest administration of Great Britain, for he will remain chairman of the Forestry Commission, a post he has occupied since 1932. Sir Roy has been a member of the Commission ever since it was set up in 1919 on the recommendation of the Acland Report, in the preparation of which he himself took an important part. The adoption of that report marked a new era in British forestry, constituting the recognition, forced by the experiences of the First World War, that the State must accept responsibility for remedying the very unsatisfactory position in the matter of forests and timber supplies, with an inadequate area of forests and a very low production per acre. For some years he was the only professionally qualified forester on the Commission.

On a recent occasion, the Society of Foresters of Great Britain met to present to Sir Roy its medal in recognition of his distinguished services to forestry, services which incidentally have not been confined to Britain, for he has also taken a very active part in all four Empire Forest Conferences, presiding over the last one, held in 1935 in South Africa. In accepting the medal, he reviewed the work accomplished by the Commission, particularly during the difficult times when it was threatened with complete stoppage, and showed how almost all the arguments used against its activities and plans had later proved wrong. The Commission's 1943 Report on Post-war Forest Policy has been acknowledged in all quarters to be a very able document, though naturally enough all its proposals do not please everyone. It has been accepted by Parliament with only minor amendments as the basis of further work; it will probably come to be known as the Robinson Report, and form a landmark second only to the Acland Report. In the latest published annual report covering the year 1944–45, the total area of plantation is shown as closely approximating half a million acres, apart from another 150,000 acres on private or local authorities' lands in respect of which grants were paid. It is indeed a great achievement for twenty-five years, but only a step on the way, for Sir Roy has set us a new target—two million acres within the next fifty years—and urges that no excuses should be accepted for reducing or postponing it.

Royal Geographical Society Awards

His Majesty the King has approved the award of the Royal Medals of the Royal Geographical Society as follows:

Founder's Medal: Brigadier Martin Hotine, director of Colonial Surveys, for his original research work in air survey, his contributions to the geodesy of Great Britain and Africa, and for his cartographic work during the Second World War; *Patron's Medal:* Colonel Daniel van der Meulen, for his exploratory journeys in the Hadhramaut in 1931 and 1939, and his contributions to the geography, archæology and ethnography of Southern Arabia.

The Council of the Society has made the following awards:

Victoria Medal: Prof. E. G. R. Taylor, emeritus professor of geography in the University of London, for her contributions to the advancement of geographical knowledge, including the study of the geographical distribution of population and industry, the promotion of a National Atlas for Britain, and her studies in the development of geographical thought; *Murchison Grant:* Mr. Gordon Manley, for his observations on the meteorology of East Greenland and his research into mountain climates and snow cover in Britain; *Back Grant:* Lieut.-Colonel Andrew Croft, for his journeys in the Arctic, especially as second-in-command of the Oxford University Expedition to Spitsbergen, 1938, and in connexion with Exercise Muskox, 1946; *Cuthbert Peek Grant*, 1946: Mr. John Wright, for his survey work on expeditions to Iceland, Spitsbergen and Ellesmere Island, and in the Sudan during the War; *Cuthbert Peek Grant*, 1947: M. André Guibaut, for his exploration of the Salween gorges, Burma, 1936–37, and of the upper Tung valley on the Chinese–Tibetan borderland, 1940; *Gill Memorial*, 1947: Commander K. St. B. Collins, for bathymetric surveys between Scotland and Iceland and in Denmark Strait under enemy attack.

United Nations Educational, Scientific and Cultural Organisation: United Kingdom Committee

Mr. George Tomlinson, Minister of Education, has appointed the following committee to consult with him, in the widest possible terms, on all matters affecting the United Nations Educational, Scientific and Cultural Organisation: Mr. Tomlinson (chairman), Sir Ronald Adam, chairman, British Council; Dr. W. P. Alexander, secretary, Association of Education Committees; Prof. P. M. S. Blackett, University of Manchester; Mr. R. S. Brownell, secretary, Ministry of Education, Northern Ireland; Mr. R. A. Butler, M.P.; Mr. R. Gould, general secretary, National Union of Teachers; Mr. D. R. Hardman, Parliamentary Secretary to the Ministry of Education; Dr. W. A. F. Hepburn (Scotland); Sir John Maud, secretary, Ministry of Education; Dr. H. W. Meikle (Scotland); Sir Philip Morris, vice-chancellor, University of Bristol; Dr. Margaret Read, head of the Colonial Department, Institute of Education, University of London; Sir Ernest Pooley, chairman, Arts Council of Great Britain; Mr. J. B. Priestley; Sir Robert Robinson, president, Royal Society; Mr. B. B. Thomas, secretary of Welsh Department, Ministry of Education; Mr. W. E. F. Ward, Colonial Office, with Mr. F. R. Cowell, assistant secretary, Ministry of Education, as secretary.

Besides this committee, nine national co-operating bodies have already been established to cover the various specialized fields of the activities of the Organisation. Their main functions are to advise the United Kingdom delegates to the conferences of the Organisation and to assist in making known and carrying out projects adopted by it. Six of these are committees covering education, arts, mass communications, libraries, museums, and social sciences. The remaining three are organisations which have undertaken the functions of co-operating bodies; they are the Royal Society, for natural sciences; the British Academy, for letters and philosophy; and the Royal Institute of British Architects, for architecture and planning.

Atomic Survey

The Atomic Scientists' Association has issued a pamphlet entitled "Atomic Survey", which is a short guide to the scientific and political problems of atomic energy. The authors are Prof. P. B. Moon, secretary of the Association (Physics Dept., The University, Birmingham), and Dr. E. H. S. Burhop, both of whom are well-known nuclear physicists, and have been engaged on the atomic bomb project. In the preface, which is contributed by Prof. R. E. Peierls, it is pointed out that the subject of atomic energy is of great topical interest and importance and that many people, quite rightly, hold strong views on the proper use of this source of power. Strong views should be based on accurate information, and although it requires an expert to understand all the technical details, it is possible to present the essential facts of atomic energy in simple language so that even the non-expert may grasp them. This the pamphlet does admirably. In its thirty-two pages, divided into fourteen brief sections, there is little, if any, information which has not already appeared elsewhere; but this is probably the first time that it has been collected together into a connected and concise form. The section headings —the elements; radioactivity and nuclear reactions; the chain reaction pile; pile problems and prospects; separation of uranium 235 from mixed uranium; the physical effects and defence against the atomic bomb; the constructive application of, and military strategic significance of, atomic energy; the British atomic energy programme; the scientist and atomic energy; the control of atomic energy; and the immediate steps to ease the tension caused by the atomic bomb—are an excellent guide to the matters discussed.

"There is not and is unlikely to be any specific defence against the atomic bomb" makes it abundantly clear, the pamphlet emphasizes, that our first major task is to solve the political problem of ensuring that atomic energy shall not be used for the obliteration of mankind. Then, and only then, can scientific men devote their energy to the intense study of nuclear behaviour; to the extension of our knowledge of a subject, which the authors state with some authority is still incomplete in spite of the spectacular advances of the last decade; and to the development of constructive applications of atomic energy.

Atomic Energy Utilization in Britain

The Atomic Energy Production headquarters of the Ministry of Supply at Risley, near Warrington, is increasing its team of design and planning engineers, to speed up the development of atomic research in Britain. Already a large technical department at Risley is planning the factories, such as the one being erected at Springfields, Lancashire, which are required for the production of fissile material. This factory, one of the war-time chemical defence plants, is being converted by the Ministry of Supply into an atomic energy centre for the manufacture of uranium metal. The processes to be carried out will consist of the refining of pitchblende concentrates, reduction to metal and the machining and finishing of uranium metal rods for atomic piles. It is hoped that building work and plant erection will be sufficiently advanced for production to begin in the late autumn. When production reaches its peak, a labour force of more than a thousand will be required, of which a number will work on continuous shifts. Most of these will be recruited locally, but it will also be necessary to bring in supervisory staff with specialized knowledge.

Gordon's Astrolabe at the Royal Scottish Museum

The executors of the late Mrs. Florence Cumming, 18, Ainslie Place, Edinburgh, have handed over to the Royal Scottish Museum an astrolabe which at one time belonged to Robert Gordon of Straloch, the famous Scottish geographer. Robert Gordon of Straloch was born in Aberdeenshire in 1580 and died in 1661. He studied at Aberdeen and Paris, to which latter city he went at the age of eighteen. When he first became interested in cartography is not known, but his later work brought him fame as one of the great map-makers of Scotland. At the request of Charles I, he prepared an atlas of Scotland, which was published at Amsterdam in 1648; and it is recorded that two years later he published in the same city a second atlas of Scotland, called "Theatrum Scotiæ", which he dedicated to Oliver Cromwell—possibly the same atlas with revised title to suit the changed circumstances. Gordon is particularly noted for his revision of Timothy Pont's maps of Scotland and Blaeu's Great Atlas of the World, published in Amsterdam in 1654, a wonderful atlas in eleven large folio volumes, of which volume six contains the maps of Scotland.

Gordon's astrolabe is an interesting and most decorative relic, typical of the European version of this ancient eastern instrument. On its edge is inscribed, "Robertus Gordonius"; the instrument was probably acquired by him before proceeding to Paris, or in Paris itself. His pride of possession can well be understood, and it would be natural that the date, 1597, should be inscribed on the newly acquired treasure. The early form of the numerals on the scales, however, would suggest that the instrument was made at least a hundred years earlier than the inscribed date. The astrolabe was the universal instrument and calculator of astronomers, astrologers, travellers, and navigators from the seventh to the eighteenth century. For over a thousand years it maintained a remarkable consistency in design, and the art of its use and construction became known in almost every civilized country. Gordon's astrolabe may be seen in the main hall of the Royal Scottish Museum, Edinburgh, where it is being temporarily shown before being incorporated in the Science Gallery collection.

Industrial Research in Scotland

THE Federation of British Industries has arranged a one-day conference to be held in the Merchant's Hall, Glasgow, on Friday, April 25. Mr. Alexander Johnston, chairman of the Scottish Regional Council of the Federation, will preside at the morning session, when Sir James Lithgow will give the opening address. Papers on research in Scotland's major industries will be read by Mr. W. Barr (on steel), Sir Wilfrid Ayre (on shipbuilding), and Mr. W. G. Marskell (on heavy engineering). The chairman of the afternoon session will be Prof. T. Alty, of the University of Glasgow, and the following five papers will be given: research as a means of providing new industries, by Dr. J. W. McDavid; chemical research for Scottish industry, by Prof. W. M. Cumming (Royal Technical College, Glasgow); Scotland's mineral raw materials, by Mr. T. H. Whitehead (Geological Survey of Great Britain); research in the light engineering industries, by Mr. J. N. Toothill; the individual Scottish firm and its application of research, by Prof. R. Hay (Royal Technical College, Glasgow). Sir Steven Bilsland, chairman of the Scottish Council, will sum up the discussion and addresses. Admission to the Conference is free, and tickets can be obtained either from the F.B.I. Scottish Office, 142, St. Vincent Street, Glasgow, C.2, or from the F.B.I. Industrial Research Secretariat, 21, Tothill Street, London, S.W.1.

Acoustics Group of the Physical Society

THE Acoustics Group of the Physical Society has been formed at an inaugural meeting held at the Royal Institute of British Architects. Mr. H. L. Kirke was in the chair and Dr. Alex Wood gave an address entitled "The Contribution of Acoustical Science to Allied Studies". The meeting was attended by some 170 persons. The principal object of the Group is to provide an opportunity for the very varied types of workers engaged on acoustical problems to meet and discuss the scientific and technical implications of their work. The officers and committee of the Group, elected at the inaugural meeting to serve for the year 1947–48, are as follows: *Chairman:* Mr. H. L. Kirke; *Vice-Chairman:* Dr. A. Wood; *Joint Secretaries:* Messrs. W. A. Allen and A. T. Pickles; *Committee:* Messrs. H. Bagenal, R. S. Dadson, Dr. C. S. Hallpike, J. McLaren, B. C. Sewell, W. West, Dr. A. B. Wood and Dr. W. Greenhouse Allt. Membership of the Group is open both to members and also to non-members of the Physical Society. It is hoped to arrange for some six meetings a year, including at least one special summer meeting, which will take the form of a symposium covering a particular aspect of acoustical investigation; reprints of papers will be circulated to members when available, and it is hoped to arrange for research panels on special topics. For further particulars application should be made to the Joint Honorary Secretaries, at the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

Announcements

PROF. F. J. M. STRATTON, professor of astrophysics in the University of Cambridge, and Prof. A. Dauvillier, of the École supérieure d'Électricité, have been elected *Correspondants* for the Section of Astronomy, and Prof. P. M. S. Blackett, Langworthy professor of physics in the University of Manchester, and Prof. Emile Henriot, professor of physics in the University of Brussels, have been elected *Correspondants* for th Section of General Physics, of the Paris Academ of Sciences.

THE Holweck Prize for 1947 of the Physical Societ and the Medaille Holweck of the Société Française d Physique have been awarded to Prof. E. N. da C Andrade, Quain professor of physics in the Universit of London, in recognition of his experimental investiga tions on the solid and liquid states.

MR. A. J. PHILPOT, director of the British Scientifi Instrument Research Association, has been appointe director of the Scientific Instrument Manufacturer Association of Great Britain, Ltd. He will continu as director of the Research Association, and wi work from the Association's offices at 26 Russe Square, London, W.C.1. Mr. Philpot will speak o "Scientific Instrument Manufacture and the Nation at the Northampton Polytechnic, London, E.C.1, o April 24 at 7.30 p.m.; admission is free, by tick obtainable from the Polytechnic.

DR. J. L. B. SMITH, for many years in charge organic chemistry at Rhodes University Colleg Grahamstown, has recently resigned to be appointe research professor in ichthyology in the College. D Smith is already well known for his ichthyologic researches, which included the announcement in 193 of the discovery of a living Cœlacanthid fish (se *Nature*, 143, 455; 1939). Dr. Smith has also bee awarded a research fellowship in ichthyology by th South African Council of Scientific and Industri Research.

MR. W. L. HALL has been appointed chief office of the Liaison Department of the British Non Ferrous Metals Research Association, in successio to Mr. W. C. F. Hessenberg, who has been appointe head of the Mechanical Working Division of th British Iron and Steel Research Association. M Hall graduated from the Royal School of Mines wit a first-class honours degree in 1936. After two yea experience in a steel works, he joined the researc staff of the British Non-Ferrous Metals Researc Association in 1938, working on galvanizing, stre corrosion of light alloys and the properties aluminium–magnesium alloys; he was transferred t the Liaison Department in 1944.

SIR WALLACE AKERS, a director of Imperi Chemical Industries, Ltd., will deliver the May lectu of the Institute of Metals on May 21 at 6 p.m.; h will speak on "Metallurgical Problems involved i the Generation of Useful Power from Atomic Energy" Admission is by ticket obtainable from the Institut

THE Council of the Royal Society will shortl consider the nomination of not more than thre marine biologists to visit the Roscoff Biologica Station (Finistère) during the summer month Those wishing to be considered in this connexio should communicate with the Assistant Secretar of the Royal Society, Burlington House, London W.1, not later than May 7, and should submit a brie statement of the investigation which it is propose to carry out, together with an indication of th inclusive dates of the visit.

A ONE-DAY school on atomic energy for journalist arranged by the Atomic Scientists Association wil be held in the Embryology Theatre, Universit College, Gower Street, W.C.1, on April 26, 1947 The speakers will be Prof. H. S. W. Massey, Prof M. H. L. Pryce and Prof. R. E. Peierls.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Structure of Fibrous Keratin

THE generally accepted model of the structure of keratin proposed by Astbury and Bell[1] is based first on the crystallographic data obtained from X-ray studies on *whole* wool fibre, and secondly upon the interpretation of experiments on *whole* fibre extension in water, that is, 100 per cent elongation indicates a complete unfolding of α-keratin polypeptide chains[2]. Electron microscopic studies[3] have demonstrated conclusively that the cortex of wool fibre is composed of two distinct components, fibrils and matrix, that the amorphous matrix is capable of considerable elongation, and that the sub-cellular fibril, which is the component responsible for the X-ray fibre pattern, may undergo extension considerably in excess of 100 per cent without rupture. New electron microscopical evidence throws additional doubt on the picture of molecular chains extended parallel to the fibre axis, and a revision of the structural conclusions seems now desirable.

Astbury and Street[4] early pointed out that all X-ray fibre patterns from wool have diffuse haloes superimposed. These do not correspond to disoriented fibrils; by precise microphotometry of the patterns and separation of that part comprising diffuse haloes, we have been able to show that the latter correspond to the truly amorphous part of the wool fibre, namely, the matrix, the diffraction pattern from which gives the same angular distribution of scattered intensity. Preparations of matrix, obtained by partial solution of the cortical cells by mild chemical treatments, give the same pattern also, which leads us to believe that the matrix consists simply of keratin molecules showing little tendency to order. These findings are confirmed by electron micrographs of matrix material (Fig. 1), obtained by the gold-shadowing technique of Williams and Wyckoff[5], showing an aggregate of particles (keratin molecules) of average diameter 102 A.

From shadow-length measurement, the molecules appear to be approximately isometric. Assuming the density to be the same as the bulk density and that the particles are spherical, the molecular weight is calculated to be 360,000. Moreover, the fibrils (1000–2000 A. wide) show further subdivision into proto-fibrils of fairly uniform size (100 A. wide by 2000 A. long); these appear to be the ultimate fibrous units and may correspond to the micelles postulated by Speakman[6] on the basis of other work. These protofibrils are often found twisted about the axis of the fibril, giving a rope-like appearance which may account, in part at least, for the angular dispersion of the X-ray reflexions. These two features are evident in Fig. 2.

Owing to the increase in contrast arising from the gold-shadowing, the protofibrils show a further significant structure, namely, a series of particles of uniform size along their length (Fig. 2). From a large number of measurements of the spacing of these along the protofibril, the average particle diameter is found to be 110 A., and it is concluded that these do, in fact, represent the keratin molecules (as in Fig. 1) linked together to give the uni-dimensional crystals. It is further significant that this spacing corresponds to the feather-keratin fibre period obtained by low-angle X-ray scattering, found by Bear[7] to be 95 A., and to half the porcupine quill keratin period, found by MacArthur[8] to be 198 A.

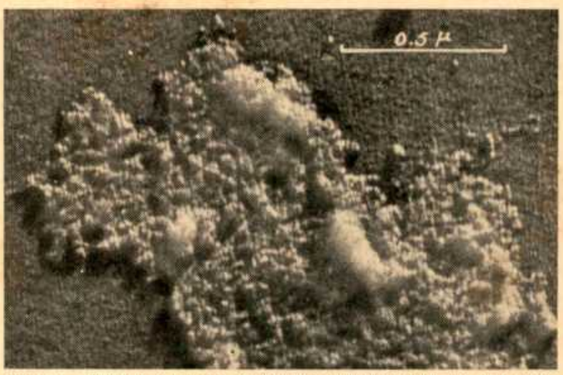

Fig. 1. GOLD-SHADOWED ELECTRON MICROGRAPHS OF KERATIN MOLECULES COMPRISING MATRIX MATERIAL FROM WOOL FIBRE. CALCULATED THICKNESS OF GOLD FILM, 9 A.

That these new features are real and not artefact is confirmed by the following. (i) They have the dimensions, within the limit of experimental error of measurement, of the particles of dispersed keratin matrix. (ii) In the background structure, usually assumed to arise from the molecules of cellulose nitrate in the supporting film, the particles have an average size of less than 90 A. This interpretation is supported by the observation by Boyer and Heidenreich[9] of such structure by direct electron microscopy (that is, without metal shadowing) of ethyl cellulose films. (iii) At fibril extremities these particles may be frequently observed in the process of splitting off the proto-fibril. (iv) The dimensions of the particles of the background vary with the nature of the supporting film (for example, polyvinyl, formal and polystyrene films show different particle sizes), whereas the spots on the fibrils remain the same.

We suggest, therefore, that the keratin molecule is a well-ordered discrete unit somewhat similar to that postulated for the globular proteins[10], and that fibrous keratin does not consist of long extended, or even partly folded, chains, but of strings of globular

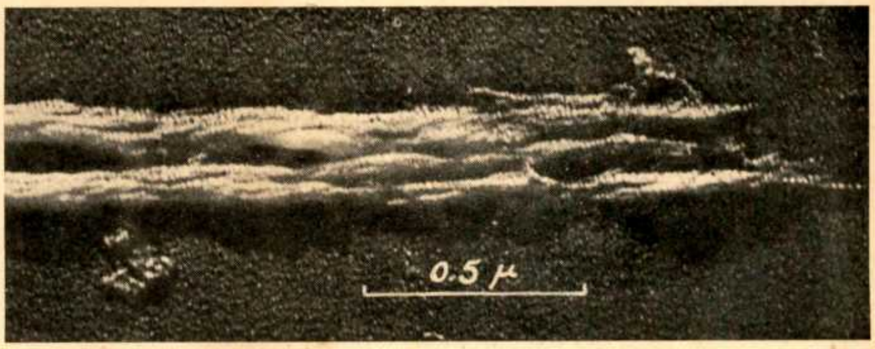

Fig. 2. GOLD-SHADOWED ELECTRON MICROGRAPHS OF FIBRILS ISOLATED FROM CORTICAL CELLS OF WOOL, INDICATING SUBDIVISION INTO PROTOFIBRILS AND SHOWING PARTICULATE STRUCTURE OF THESE. CALCULATED THICKNESS OF GOLD FILM, 9 A.

molecules. There is electron microscopical evidence that this may also be the case with other fibrous proteins[11]. Within each separate molecule the folding of the polypeptide chains must be much more extensive than the α-fold suggested by Astbury for the keratin-myosin group. This new model would not be inconsistent with the X-ray data on α-keratin. The β-keratin pattern cannot now arise from the complete unfolding of the polypeptide chain, but is more probably connected with the presence of interfold water. The importance of water in the $\alpha \rightleftharpoons \beta$ transformation has never been adequately explained by the earlier models.

A full account of this work will be published shortly.

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Formation of Coking Coal by Thermal Treatment of a Cannel Coal

Geological and petrographical investigations have shown that the residues of the higher plants and the microplants (*Ölalgen*) have both played a part in coal formation: coals formed from the former have been called *humus coals*, while those from the latter are known as *sapropelite coals*. According to G. Stadnikoff[1], the vitrain of the banded bituminous coals is of mixed origin, being formed from humus and the unsaturated fatty acids of the Algæ fats. The humus coals consist of bitumens and humus, and on dry distillation give primary tars which contain phenol: the sapropelite coals (bogheads and cannels) consist of fatty acids and their transformation products, and give primary tars, rich in paraffinic and naphthenic substances, but containing no phenols.

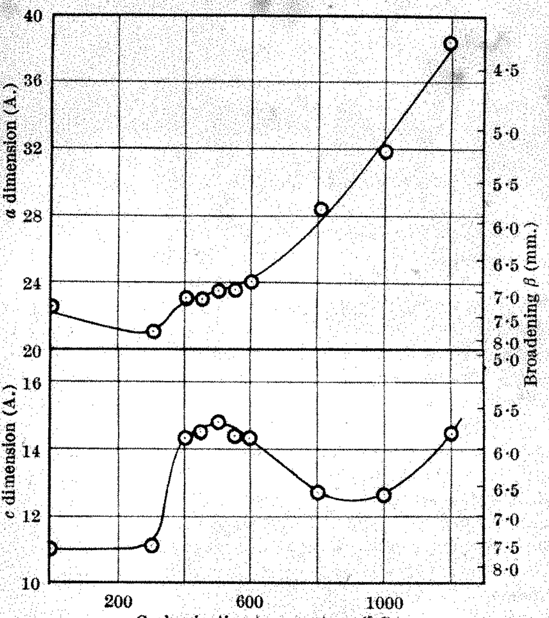

Fig. 1

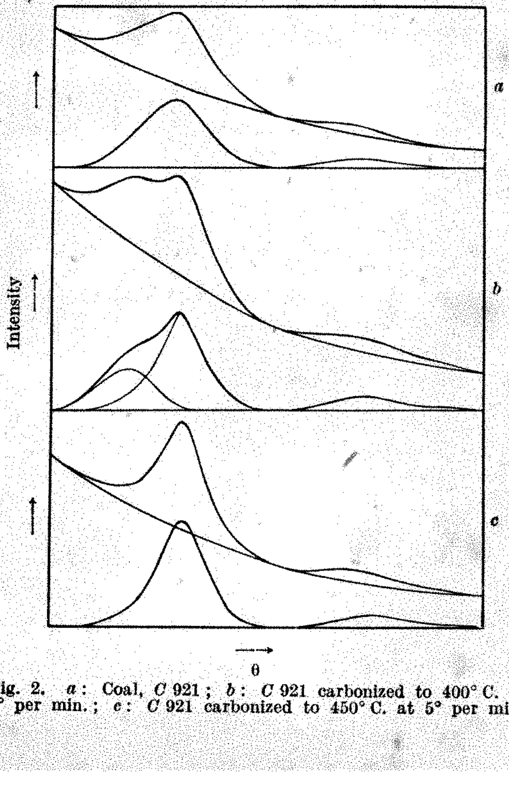

Fig. 2. *a*: Coal, *C* 921; *b*: *C* 921 carbonized to 400° C. at 5° per min.; *c*: *C* 921 carbonized to 450° C. at 5° per min.

The X-ray examination of coals[2] has shown that coking coal bitumens consist of lamellar, polynuclear aromatic molecules which contain a small but critical proportion of oxygen. The inner diffraction halo of such coals shows a characteristic variation in half-peak width when the coal is subjected to increased temperature, passing through a more or less pronounced minimum value in the neighbourhood of 500–550°. The X-ray examination of some fifty or sixty bituminous coals and lignites has shown that this behaviour is characteristic of coking coals. If the average crystallite dimension along the *c* axis (calculated from the half-peak width of the inner (002) diffraction) is plotted against carbonizing temperature, the curve obtained shows a maximum in the neighbourhood of 550°. A north Staffordshire cannel coal (C, 86·38; H, 6·65 per cent: ash, 1·26; moisture, 1·15; volatile matter (ash free, dry), 44·8 per cent), although practically non-swelling (B.S. swelling No. 1–1½) has been found to give a *c*-dimension-carbonization temperature curve (Fig. 1) with a pronounced maximum at 550°. This cannel coal was exceptional in another respect: whereas the coal itself gave a powder photograph the microphotometer trace of which showed a symmetrical inner halo (Fig. 2*a*), after heating the coal in nitrogen to 400° at 5° per min., the inner halo then showed a pronounced asymmetry (Fig. 2*b*), which no longer

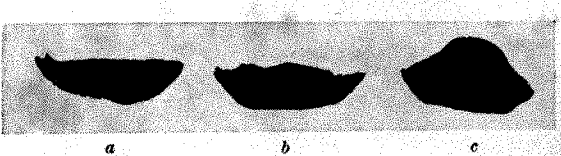

Fig. 3

appeared in the powder photograph of the coal after heating to 450° at 5° per min. (Fig. 2*c*).

A probable explanation of these phenomena is that during the heating at 5° per min., some of the naphthenic or paraffinic bitumen in the cannel escapes volatilization and undergoes aromatization, being converted into the coking coal type of bitumen. This suggests that there should be a concomitant change in caking power. Fig. 3*a* shows the coke button obtained from the cannel in the B.S. crucible swelling test, that is, by heating rapidly 1 gm. of the finely powdered coal in a silica crucible over a bunsen burner; Fig. 3*b* is a photograph of the button obtained in the same test from a sample of the cannel which had been preheated to 350° at 5° per min.; and Fig. 3*c* is of the button from the cannel preheated to 400° at 5° per min. The increase in swelling property caused by thermal pretreatment is obvious, and is made even more striking by the fact that the preheating to 400° gave an agglomerated product (loss in weight, 16 per cent) which was recrushed to a powder before carrying out the crucible swelling test.

This result has a practical significance in that the British Standards crucible swelling test, which involves rapid heating, may give misleading results if the coal under examination contains an appreciable proportion of sapropelite material. The theory that the coking coal bitumens owe their origin to the thermal decomposition of sapropelite material does not appear to be tenable in view of the fact that cannel coal sometimes occurs as one of the banded constituents of bituminous coal seams.

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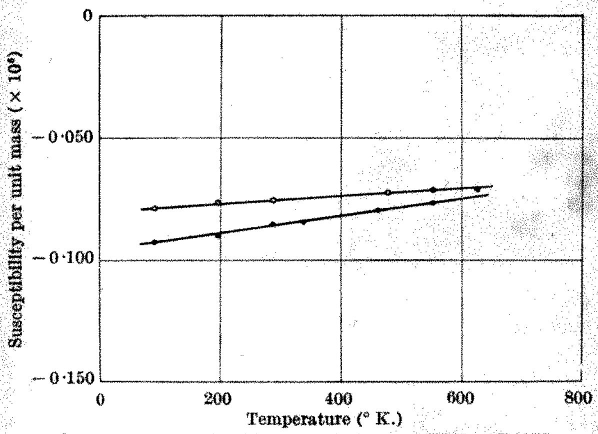
Temperature-Dependence of Magnetic Susceptibility of Annealed and Cold-worked Copper

INVESTIGATIONS recently carried out on the variation with temperature of the magnetic susceptibility of annealed and cold-worked copper have shown a different temperature-dependence in the two cases. A qualitative attempt is made to account for the difference on present theoretical lines.

The metal used was very pure 'H.S.' brand copper supplied by Johnson, Matthey and Co., Ltd., in the form of rods 15 cm. long and 5 mm. in diameter. The iron content was less than 0·005 per cent. A rod was first annealed for 10 hours in hydrogen at 950° C. and then either cooled slowly or 'quenched' in water. Both processes gave similar magnetic results, indicating that the specimens were free from ferrous impurity. In the case of the 'quenched' specimen, dissolved iron atoms should be retained in solution at room temperature, while slowly cooling the specimens should allow precipitation of the ferrous impurity.

The Gouy method and an electrodynamic balance[1] were used in the magnetic measurements. Determinations were made over the temperature range 90°–630° K. After a run had been taken with the annealed specimen, it was cold-worked by wire drawing, and its magnetic susceptibility measured over the same temperature range. Before measurement the specimen was allowed to recover for 24 hours[2]. The higher temperatures were not maintained for long periods and annealing did not take place. This was shown by the fact that the room temperature susceptibility value could be repeated afterwards.



OPEN CIRCLES, COLD-WORKED COPPER; FILLED CIRCLES, 'QUENCHED' COPPER

In the graph it is seen that the susceptibility varies linearly with temperature, the quenched specimen giving a 21 per cent change over the temperature-range as against a 12 per cent change in the case of the cold-worked specimen. Cold-working in the case shown was a 2·84 per cent reduction in diameter due to wire-drawing.

The reduction in numerical susceptibility in diamagnetic metals due to cold-working has been noted[3,4] and attributed to either of two causes: (i) change in electron orbits; (ii) precipitation of ferrous impurity[5]. It is considered in the present work that the decrease in diamagnetic susceptibility is not due to the presence of impurities. The reasons for this conclusion are (*a*) the metal is extremely pure; (*b*) the room temperature value of the susceptibility could be reproduced in the case of the cold-worked specimens after the specimen had been taken through a cycle at the higher temperature points; (*c*) complete absence of field-dependence of susceptibility; (*d*) had ferrous impurity in paramagnetic form been affecting the results, then the susceptibility would have been likely to diminish (numerically) at the low temperature, 90° K. Thus it is concluded that the decrease in diamagnetic susceptibility on cold-working indicates that copper is magnetically strain-sensitive.

Stoner[6] has suggested that increase in paramagnetic susceptibility with rise in temperature found by Sucksmith[7] in the alkali metals is due to thermal expansion. He deduces the approximate expression for the gram-atomic susceptibility for the quasi-free electrons:

$$(\psi_A)_e \times 10^6 = 32{\cdot}1\,(q/V_0)\{1 - 6{\cdot}11 \times 10^{-9}\,(T/V_0)^2\},$$

where q is the number of quasi-free electrons per atom and V_0 is the value of the maximum electron energy at absolute zero expressed in equivalent volts. Thermal expansion decreases V_0 and hence increases $(\psi_A)_e$. Cold-work, on the other hand, should also decrease V_0, since it may be considered as giving rise to a trapping of electrons in regions of lower potential energy. To account for the smaller decrease of susceptibility with temperature in the case of the cold-worked specimens, it is then necessary to suppose that further decrease in V_0 is less than for the annealed metal.

Further work will be published elsewhere.

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'Incipient Shrinkage' of Collagen and Gelatin

IT is well known that if collagen is heated in water to about 62° C. it undergoes shrinkage, and that if it is then allowed to dry, its ability to re-hydrate on immersion in water is considerably reduced. Although opinions differ as to the precise mechanism of hydrothermal shrinkage, the phenomenon is generally agreed to be a cumulative effect in which the polypeptide chains, by the rupture of certain cross-links of various strengths, assume a more compact space arrangement than their hitherto extended forms. On drying in this compact state, their ability to take up water is considerably reduced, due probably to the formation of fresh inter-chain links.

A similar reduction in the re-hydrating power of collagen, but not accompanied by shrinkage, can be obtained by heating it in an atmosphere of high relative humidity at temperatures so low as 45° C. Deaminated collagen and gelatin also show this effect, and in the case of gelatin, it is accompanied by an elevation in 'melting point', which may amount to as much as 50° C. or more, where thin gelatin layers are concerned. Under conditions of very high relative humidity (*c.* 100 per cent) gelatin undergoes marked hydrothermal shrinkage at 45° C., and exhibits rubber-like properties similar to shrunken collagen, a phenomenon not usually observed with gelatin on account of its ready solubility in water at about 35° C.

The accompanying table shows the magnitude of the changes in absorption of water of the three proteins referred to, brought about by heating in atmospheres of various relative humidities at 45° C. In each case, after heating at 45° C., the protein was allowed to come to equilibrium with an atmosphere of 70 per cent relative humidity at 20° C., and in no case did the final weight differ from the original, before heating, by more than 1 per cent. The water absorption figures indicate the grams of water absorbed by 100 gm. of protein when immersed in distilled water at 20° C. for three days in the case of the collagens, and 36 hours in the case of gelatin.

Protein	Period of heating at 45° C. (days)	Relative humidity (%) 54	69	82	*c.* 100
Collagen	5	126	124	113	111
	20	104	103	93	88
	80	97	94	90	75
Untreated collagen, 126 ; shrunken* collagen, 95					
Deaminated Collagen	5	100	102	100	92
	20	86	89	89	76
	80	85	84	74	58
Gelatin	5	645	643	567	435†

* Collagen shrunken by immersion in distilled water at 90° C. for 3 min., allowed to dry out at 20° C. Some gelatinization had occurred, and therefore the water uptake figure given is probably higher than the real value for shrunken collagen.

† Hydrothermal shrinkage observed.

Air-dried collagen, containing about 13 per cent of water, can be heated in air to at least 100° C. without showing signs of shrinkage. Only when heated at this temperature in an atmosphere of practically 100 per cent relative humidity, or in the presence of excess water, does shrinkage occur. Since heating a protein in an atmosphere of high relative humidity is merely equivalent to heating it under conditions of comparatively high water content, it is apparent that a certain minimum water content is necessary before shrinkage can take place, even at temperatures so high as 100° C.

It seems likely that the effect which has been described is due to the rupture of some of the weaker cross-bonds of the protein molecule, which permits local increases in compactness, followed, on drying, by the formation of new cross-bonds. Physical shrinkage is not observed since insufficient links are so affected.

On this hypothesis, the term 'incipient shrinkage' seems appropriate to describe the phenomenon.

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Exchange between Chromium Ions and the Szilard Effect

CHROMIUM hydroxide ($Cr(OH)_3$) was subjected to the action of slow neutrons produced by the cyclotron of the Collège de France and was then transformed into the sulphate by dilute sulphuric acid. Potassium dichromate was added to this solution of the sulphate so as to obtain an equimolecular system of Cr^{+++} and $\frac{1}{2}$ $Cr_2O_7^{--}$. After a time which varied from 15 to 120 minutes, the chromic salt was precipitated by boiling with ammonium hydroxide and the dichromate as the barium salt.

The activities of these precipitates, as measured by a Geiger–Müller counter, showed that in the neutral or acid medium there was no appreciable exchange. The following, for example, are the results obtained for a solution of *p*H about 3.

Time of contact	$Cr(OH)_3$	$BaCrO_4$
15 min.	116 ± 10	10 ± 7
60 ,,	83 ± 10	0 ± 6
120 ,,	71 ± 10	7 ± 6

Potassium iodide, which catalyses the exchange between arsenite and arsenate, has no action in our case.

The impossibility of observing an exchange between the Cr^{+++}, $Cr_2O_7^{--}$ ions leads one to think that it would be easy to find a Szilard and Chalmers effect with the dichromate. 500 gm. of dichromate were, therefore, irradiated with neutrons and dissolved in several litres of water which contained 200 mgm. of chromium sulphate. The latter was precipitated by ammonia and the hydroxide separated by centrifuging. The activity of the precipitate was found to be of the order of 100–300 counts/min., whereas the total activity of the dichromate was 30,000 or more counts/min.

Thus, if a Szilard and Chalmers effect does exist in this case, it is extremely weak.

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Evidence for the Formation of a Copper Carbonyl

IN order to explain the 'metallization of insects' observed by Zelinski[1], and his own observation of a copper mirror produced by passing carbon dioxide through a heated tube containing a mixture of copper oxide and charcoal, Bertrand[2] postulated the intermediate formation of a copper carbonyl. Mond and Heberlein[3], being unable to reproduce Bertrand's results, were of the opinion that the deposition of the copper mirror was caused by the adhesion and sintering of copper oxide helped by its heat of reduction by carbon monoxide. The existence of a copper carbonyl has also been postulated by Boomer, Morris and Argue[4] to explain the removal of copper from the metallic catalyst during the synthesis of methanol.

In order to remove traces of oxygen from carbon monoxide, I heated a roll of copper gauze (initially slightly oxidized at the end of the roll nearest to the point of entry of the gas) in a glass combustion tube, by means of an electric furnace, the temperature in the centre of which was maintained at about 550° C. while the carbon monoxide (containing a little air, but no chloride) was being passed through the tube. During the course of several weeks of continuous heating in the stream of carbon monoxide, a substantial copper mirror was formed in the section of the tube which had attained a temperature of about 250–400° C., and a purple mirror in the centre section (550° C.). As the copper gauze was only in contact with the glass tube at a few points, and copper is non-volatile at the temperatures of the experiment, this phenomenon can best be explained by the formation of a very minute quantity of copper carbonyl at about 250° C., and its subsequent decomposition at higher temperatures. The purple coloration is due to interaction between the deposited metallic copper and the glass at the highest temperature (cf. Mond and Heberlein). A similar experiment using nitrogen instead of carbon monoxide did not produce a copper mirror, the glass tube remaining quite clear.

The fact that a copper mirror was deposited in a part of the tube where no copper oxide was present at any time means that Mond's criticism of Bertrand's experiments is inapplicable in this case. A minute deposit of a brown substance (free from chloride) in the cooler part of the glass tube may be the actual carbonyl. Tests were made for the presence of a chloride impurity, which could produce a white sublimate of cuprous chloride (cf. Robinson and Stainthorpe[5]), but this was found to be absent.

It is planned to carry out further investigations on this subject.

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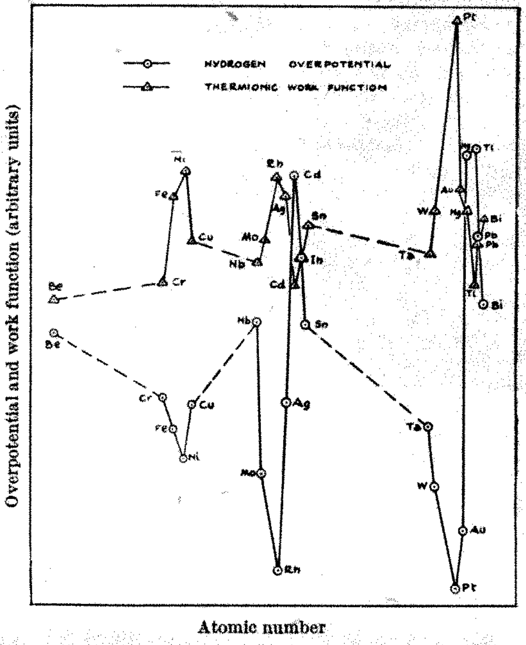
Hydrogen Overpotential and the Thermionic Work Function

EXTENSIVE recent work[1,2] on the hydrogen overpotentials at a large number of metal electrodes in aqueous solution allows a re-evaluation (see ref. 3) to be made of the relation between the hydrogen overpotential at various cathodes and the position of the cathode material in the periodic table. In the accompanying graph, the available values[1,2] for the hydrogen overpotential at the intermediate current density of 10^{-3} amp./sq. cm. at various cathode materials, the surfaces of which have been prepared in approximately the same way, are shown in relation to the atomic number of the metals concerned, from which a periodic variation may clearly be discerned.

It is of interest to compare this variation with the corresponding one for the thermionic work functions of the metals[4]. From the graph it seems tnat if, on transition from one metal to another, the second has a smaller overpotential than the first, then the second has a larger work function than the first, and *vice versa*. This relation appears to hold in every case for which data are available. There is also a general tendency for metals at which there is a comparatively low overpotential to have a comparatively high work function. The tendency for the converse is less marked.



According to Gurney's theory of hydrogen overpotential[5], the potential of a working electrode is directly related to its work function, and it appears from the theory that a high work function should tend to be associated with a large overpotential. According, however, to Adam[6], no relation between work function and overpotential is indicated by Gurney's theory, because "although electrons have to be extracted from the metal, they do also in a reversible electrode, and in either case the [work functions] cancel out . . . through a second contact potential elsewhere in the circuit". Both these interpretations seem in disagreement with the observed relations; the latter appear at variance in general with theories of hydrogen overpotential which postulate that the transfer of an electron from electrode to ion is the slow stage in the reactions occurring at the cathode[7,8].

As the work function of a metal is a measure of its electron affinity, it must be a measure of the tendency of the metal to take an electron away from the hydrogen atom and bind it to itself. Thus, it might be expected that the work function of metals would run roughly parallel to the ability of the latter to adsorb atomic hydrogen. Metals of comparatively high work functions, for example, nickel and platinum, would thus be expected to tend to act as comparatively good catalysts for the formation of molecular from atomic hydrogen. If, therefore, it be assumed that a catalytic reaction of adsorbed hydrogen forms the limiting stage in hydrogen overpotential, it follows that a large work function should correspond to a low overpotential, and the general features of the graph become more intelligible.

It may finally be noted that the order of increasing activation overpotentials of the metals is roughly the converse of their order with respect to hydrogen overpotential[9,10]. Thus for metal overpotentials, where the probability of a catalytic mechanism is remote, there appears to be a rough parallelism between work function and overpotential, as would be expected from the neutralization theory[11].

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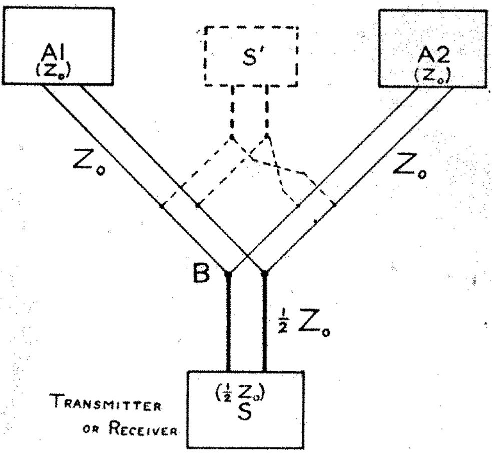
Apparent Breakdown of the Reciprocity Law for Transmission Lines

RADIO-FREQUENCY transmission lines are normally 'matched' for maximum power-transfer by making the load impedance as transformed by the line equal to the complex conjugate of the generator impedance. One consequence of the reciprocity theorem is that the same matching condition applies when the transmission takes place in the opposite direction, that is, the functions but not the impedances of the load and generator are interchanged. In an application to multi-element directive arrays, an apparent failure of this principle has been found. Further examination has elucidated the reason for the paradox, but as it is felt that the behaviour of such arrays for incoming radiation is not generally understood, the facts seem worth recording. Similar considerations may arise in other radio-frequency problems (for example, nuclear physics accelerators) where branching feeders are used.



Consider the system shown in the figure, where the parallel lines represent transmission line of the characteristic impedance indicated, omitting for the present the dotted lines. If $A1$ and $A2$ are aerials of impedance Z_0 each, the generator S feeds into $\frac{1}{2}Z_0$ due to the two loads being joined in parallel at B, so that the matching condition is that the impedance of S should be $\frac{1}{2}Z_0$, and pure travelling waves are generated in the feeders. For the case of reception of incoming radio waves, the matching condition appears not to be satisfied; for example, $A1$, having impedance Z_0, feeds into $\frac{1}{2}Z_0$ at B due to $A2$ and S in parallel, and one would expect reflexion of incident energy to occur at B. However, when transmitting, the aerial elements $A1$ and $A2$ were energized in phase, giving directional propagation—usually along the array-normal. For a received wave arriving along the array-normal, $A1$ and $A2$ will be energized in phase, and then it is easily shown that no energy is reflected at B, the system being equivalent to two generators of impedance Z_0 in parallel feeding a load of $\frac{1}{2}Z_0$.

Thus we see that although reciprocity does not hold for a part of a directive array considered separately, it holds for the complete system; and if the direction of radiation is reversed the matching condition is unchanged. Absence of reflexion at B only occurs for waves arriving along the array-normal (energizing $A1$ and $A2$ in phase). Waves arriving along another direction may energize $A1$ and $A2$ equally in antiphase; complete reflexion then occurs at B, all the energy being re-radiated, and none reaches the receiver, whatever its impedance. Incidentally, the resulting polar-diagram zero has an exact counterpart in the converse process of radiation from the array. For the general incoming wave both modes are excited, so that partial reflexion of energy occurs at B, just as it did in the case already considered in which only $A1$ was energized. The only matching condition which we can apply is that for the part of the energy in the in-phase mode, which is just the reciprocal of the matching condition for the transmitting case. However, application of this condition does not preclude the reflexion of energy, as it would in a simple feeder system.

In a radar application described in detail elsewhere[1] this principle is extended by the addition of the feeders, shown dotted in the figure, giving a feeder bridge having four arms each λ/4 long. By this means the energy in both modes (phase and antiphase at *A*1 and *A*2) can be absorbed, one mode into each of two receivers, the array then giving two polar diagrams simultaneously and quite independently into the two receivers. In such an arrangement neither receiver absorbs any power which could have reached the other receiver, even if that had been the only receiver present, but receives only energy which would otherwise have been re-radiated by the array.

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Spiral Cracks in Glass Tubing

DR. J. J. HOPFIELD's description of spiral cracks in glass capillary tubing[1] reminds us that similar cracks were observed some ten years ago with thin-walled tubing, during the development of 'flashed' sodium-resistant glasses. The tubing in question was a conventional soda-glass, about 5 mm. in external diameter and rather less than 1 mm. in wall thickness, flashed internally with a thin layer of rather weak sodium-resistant glass. Specimens of such tubing in which the expansions of the two glasses were not sufficiently closely matched developed, soon after drawing, spiral cracks. The pitch of the crack increased towards the end of the stick of tubing, as in the specimen described by Dr. Hopfield, and tended to become infinite. In addition, the slope of the spiral varied throughout each turn in a regular manner. Cracks of the type described were only found in tubing having very high strain between the flashing and the base glass, the circumferential tension in the flashing glass corresponding to a stress of about 200 kgm. per sq. cm., a figure of the same order as the average breaking stress of the glass.

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[1] *Nature*, **158**, 582 (1946).

Friction and Wear

IN the literature of friction it has been generally assumed, often implicitly, that there is no causal relationship between wear and friction. Schnurmann[1] has shown that the results of measurements of static friction on naked cadmium surfaces at temperatures down to − 100° C. indicate that abrasion cannot be the only factor responsible for the elementary mechanism of friction, and that an essential part is played by deformation. The following treatment, however, provides direct evidence for this lack of a causal relationship. It is shown that the work involved in that portion of the abrasion which actually results in wear is a negligible proportion of the frictional work.

The amount of work required to abrade material from the bearing surface will be a maximum if this material is all removed as single atoms, and this maximum amount of work may, therefore, be calculated from thermochemical data leading to the heat of atomization of the materials involved. If the frictional force operating during a wear determination is measured, we can then calculate both the total frictional work and the maximum work necessary to produce the observed amount of wear.

For a composite material containing 69 per cent by weight of calcite and 31 per cent by weight of an *o*-cresol formaldehyde resin of approximate empirical formula (C_8H_8O) tested against mild steel with a normal pressure of 50 lb./sq. in. at a speed of 50 ft./sec., the highest wear recorded corresponded to abrasion of 1 gm. for the expenditure of 726 kcal. of frictional work. The approximate heat of atomization of the material may be derived from the published values of the heat of formation of calcite, the heat of combustion of *o*-cresol with allowances for the additional atoms and bonds involved in the resin, and the heats of combustion and of atomization of the elements involved.

The heat of atomization of 1 gm. of the material is thus found to be 10·6 kcal., or 1·4 per cent of the total frictional work done. It follows, therefore, that the proportion of the frictional work to be ascribed to this abrasion process is probably several orders of magnitude less than 1 per cent, when allowance is made for the abrasion of particles considerably larger than single atoms.

The wear of the steel bearing-member was not measured in the above work and was not allowed for in the calculation. It was measured in another experiment in which it was known to be very much larger, and even in this case a similar calculation showed that it could not account for more than 1 per cent of the total work done. The above conclusion is therefore not affected.

In order not to prejudice the argument, high values have been used in the thermochemical calculation for those quantities the true values of which may still be open to question, for example, the latent heats of vaporization of calcium and carbon.

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Feb. 18.

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[1] Schnurmann, R., *Proc. Phys. Soc.*, **53**, 538 (1941).

Control of Low-Temperature Injury in the Victoria Plum

IT is well known that many kinds of fruit and vegetable after picking may be damaged during storage at low temperature above the freezing point. The phenomenon has been widely studied, and there is a considerable literature on the low-temperature injury relations of the apple, plum, peach and grapefruit. That the conditions known as low-temperature internal breakdown of the apple and plum, as well as woolliness of peaches and pitting of the rind of grapefruit are the final and visible result of a series of reactions deriving from an initial and sustained shift of metabolic balance, has seemed fairly evident. But observations of the influence of 'external' factors of primary importance, namely, level of temperature and duration of exposure as well as of 'internal' factors such as varietal type, degree of ripeness at picking, etc., have revealed a considerable complexity which cannot be elucidated by any simple hypothesis. It has, for example, been observed that after a limited period of exposure, the maximum percentage of injured fruits (plums and grapefruit) will often be found in samples subjected to storage at temperatures of an intermediate range. But after more prolonged exposure the highest proportion of injured fruits is found at the lowest temperature of storage.

Van der Plank and Rees Davies[1] have provided for these observations an ingenious explanation ; they have suggested that the lower the temperature the greater is the amount of *actual* injury. But the lesser injury sustained at higher temperature becomes manifest more rapidly. Thus when the percentage of injured fruits after exposure of moderate duration is plotted against temperature of storage, a typical humped curve is obtained, which, however, with longer exposure becomes transformed to a sigmoid curve with a maximum at the lowest temperature and tailing to zero at some higher temperature. In its final form this curve represents the limit of manifest injury.

More recently, Plank[2] has criticized the theory of Van der Plank and Rees Davies and has suggested that there are two main types of reactions involved, one leading to an accumulation of a cell-poison (*Zellgift Bildung*) and the other to its removal (*Zellgift Veratmung*). The reaction velocities for the processes that lead to the accumulation of the cell-poison and for those which lead to its removal are both related to temperature by equations of the form

$$\log y = \log y_0 + at,$$

where y_0 is the reaction velocity for $t = 0°$ C. and a is its temperature coefficient. The values of a may vary within limits dependent upon the values of Q_{10} which are to be expected in the metabolism of plant tissue. By selecting values of a, he produces pairs of curves within the co-ordinates y and t which intersect at a critical value of t, that is, at which the rates of production and removal of poison are equated. For a given fruit of critical temperature t_K, exposure for any length of time to higher temperatures will not result in injury, but exposure to lower temperature will produce injury in longer or shorter time. From statistical considerations it is supposed that a given sample of fruits will have a frequency distribution of critical temperature, which will fit a curve of binomial form, and Plank builds curves based on the variations of the constants of his equations, resembling the experimental curves for low-temperature injury published elsewhere.

I have[3] previously raised the objection to an all-embracing theory of this sort for plums on account of the observed fact that at least two types of injury can be symptomatically distinguished, and that the form of the temperature-injury curve is more complex than that suggested by other investigators. Plank[4] assumes in explanation of my curves that there are two superimposed sets of processes, each tending to a distinctive end-point and with quite different reaction velocity constants.

Recent observations I have made are of interest both practically and in connexion with the above considerations, since they are not inconsistent with a theory of production and removal of a toxic substance. It has been found that when Victoria plums are exposed to a temperature of 31° F. for a period of five weeks, they are damaged to the extent of 100 per cent, the type of injury being that known as 'internal browning'. If, however, between the 15th and 20th day of exposure they are warmed to 65° F. and only returned to 31° F. after two days, they can then be exposed to the lower temperature for a further period of 15–20 days without injury. An extension of this further period beyond 20 days results in the appearance of internal browning. Warming on the 5th or 25th day only partially reduces the proportion of injured plums. Warming at day 0 (delayed storage) has scarcely any effect.

It is relevant to recall that Kidd and West[5] reported in 1935 a somewhat similar phenomenon when they subjected apples susceptible to a functional disorder known as 'superficial scald' to brief intermittent warming treatments when stored at 3° C. There resulted an almost complete control of scald.

These experiments, therefore, show that the life of the Victoria plum may be extended by as much as 50–75 per cent of that previously possible if the fruit is stored at 31° F. and warmed for two days between the 15th and 20th day.

The way, therefore, seems open to investigations which may possibly have some far-reaching effects upon practice in handling those types of fruits which are susceptible to low-temperature injury.

Details of these experiments are shortly to be published elsewhere, and further investigations along these lines are being projected.

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Feb. 24.

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[1] Van der Plank, J. E., and Davies, R., *J. Pomol. and Hort. Sci.*, **15**, 226 (1937).

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[3] Smith, W. H., *J. Pomol. and Hort. Sci.*, **18**, 74 (1940).

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A Morphological Change Induced in Leaves of *Theobroma* cacao by Mineral Deficiency

PREPARATIONS for breeding a strain of *Theobroma cacao* L. resistant to the swollen-shoot virus which threatens the cacao industry of the Gold Coast[1] have included the collection of commercial types of *T. cacao* and of related species of *Theobroma*, some of which have been shown to give compatible crosses with *T. cacao*[2]. With the assistance of the Imperial College of Tropical Agriculture, seed from selected trees has been introduced to the Gold Coast from Trinidad. As a precaution against the introduction of witches' broom disease (*Marasmius perniciosus* Stahel) pods were surface-sterilized before dispatch by air ; seedlings were quarantined for a minimum period of six months in Accra, which is twenty miles distant from the cacao-growing area.

Distressing signs of lime-induced chlorosis appeared in a number of early importations which had been potted in a mixture of soil, compost and marine sand containing a high percentage of shell, and had been watered with limed water. In addition to symptoms of acute iron deficiency, a few plants showed a leaf deformation which consisted of a number of sharp entations at the leaf tip: a normal cacao leaf is ntire (Fig. 1).

This deformity has been reproduced in exaggerated rm in cacao seedlings grown in water cultures lacking both iron and manganese. The basic solution f Reeve and Shive[3] was used at a potassium con-entration of 50 p.p.m. with the addition of 0·5 p.p.m. ach of boron and zinc. Plants were grown in black-ned glass jars of 800 ml. capacity; the solutions ere aerated daily and adjusted weekly to a reaction f *p*H 6·0. There were four replicates of the treatment, each of which produced deeply indentate eaves (Fig. 2) in a flush of growth developed in leven to thirteen weeks after transference to culture. leven out of a total of fifteen leaves were affected; hey were chlorotic and afterwards developed tip corch (Fig. 3). The plants ceased elongation after wenty weeks in culture and produced no more leaves efore dying.

The four plants had been taken at random from wenty seedlings which had been grown for eleven eeks in quartz sand and distilled water; the re-naining sixteen seedlings produced entire leaves hen grown under parallel conditions in solutions ontaining 1·0 p.p.m. iron and 0·25 p.p.m. manganese. nly entire leaves have been formed by a second eries of forty plants, including eight lacking only ron and eight lacking only manganese, which have een grown for periods of up to thirty weeks in the ame basic solution.

Since leaf shape, particularly the degree of dentation, may be used to separate species in certain enera, any induced modifications are of general nterest. Harder and his colleagues have produced a hange from entire to dentate leaf form in certain ucculent plants by increasing the length of day[4]. They have shown that a leaf exposed to long days can transmit a stimulus which gives rise to long-day character in other leaves; the stimulus apparently travels in the plant along the same path as solutions injected through the petiole of the exposed leaf[5].

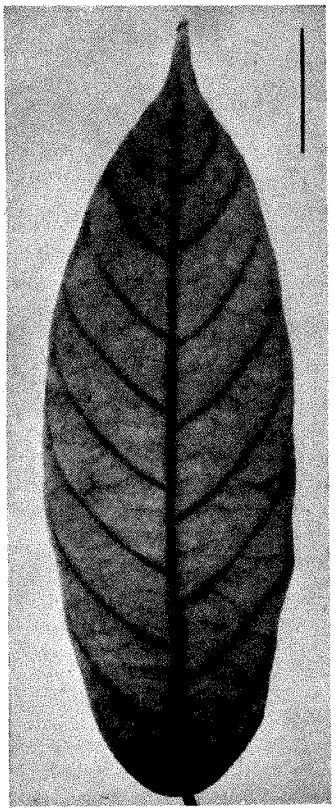

Fig. 1. NORMAL CACAO LEAF

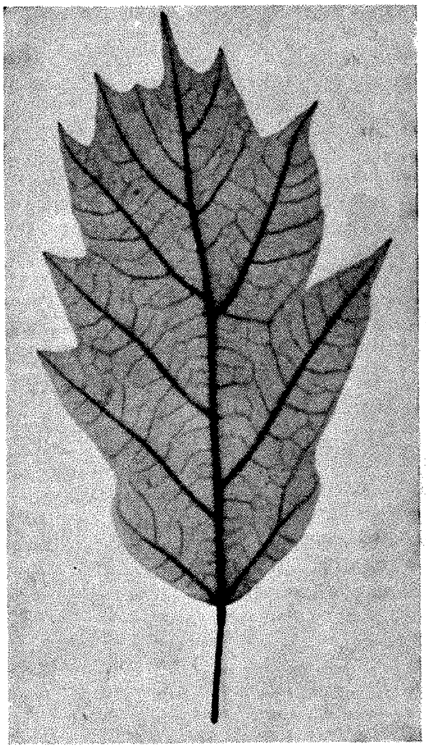

Fig. 2. INDENTATE LEAF FROM CULTURE LACKING IRON AND MANGANESE

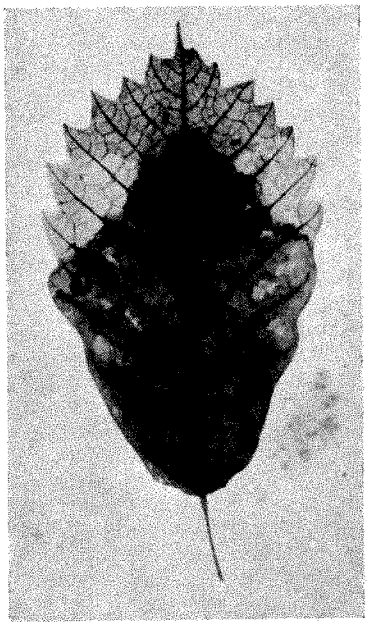

Fig. 3. TIP SCORCH DEVELOPED BY INDENTATE LEAF ON AGEING

There would, however, appear to be no record of the production, by manipulation of the mineral nutrient supply, of a change of leaf shape comparable to that here described. While modifications of leaf size and thickness are associated with deficiencies of a number of major and minor elements, changes in leaf outline are usually slight, the more notable being those accompanying zinc deficiency.

M. GREENWOOD
A. F. POSNETTE

Department of Agriculture and
West African Cacao Research Institute,
Tafo, Gold Coast. Jan. 22.

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[2] Posnette, A. F., *Trop. Agric.*, Trinidad, **10**, 188 (1945).

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Mechanism of Hydrogen Peroxide Formation by Spermatozoa and the Role of Amino-Acids in Sperm Motility

IT has been demonstrated[1], using freshly ejaculated bovine semen diluted with egg-yolk medium, that spermatozoa produce under aerobic conditions an inhibitor of sperm respiration. The inhibitor was afterwards identified chemically[2] as hydrogen peroxide, and was shown to be formed as the result of metabolic activity of spermatozoa upon a substance present in the egg-yolk and its dialysable portion. Since then, further purification and characterization of the egg-yolk substance have been carried out; and it has now been demonstrated that hydrogen peroxide is formed as the result of an oxidative deamination by spermatozoa of the substance isolated, which is replaceable, with the same effect, only by *l*-tryptophane, *l*-phenylalanine and *l*-tyrosine, but not by any of many other amino-acids tested. The inhibition which develops as the result of the above reaction can be detected not only by its effect upon oxygen consumption but also by its effect upon the reduction of motility of spermatozoa.

The isolation of the substance, in presence of which spermatozoa produce hydrogen peroxide, was effected by dialysis of egg-yolk, followed by successive precipitations and/or extractions with organic solvents of the dialysable portion or the fractions separated therefrom. The isolated substance is easily dialysable, and soluble in water, 90 per cent ethanol and *iso*-propanol. It is not fermentable by baker's yeast. Quantitative analysis revealed that it contains 10·7 per cent nitrogen, 4·2 per cent ash and 0·13 per cent sulphur (Weiler and Strauss), no phosphorus nor fermentable reducing substances. In low concentration it gives strong reactions for tryptophane and tyrosine. Only traces of glucosamine were detected before or after acid hydrolysis.

Washed suspensions of living spermatozoa of the bull, in the presence of the isolated substance, produced aerobically ammonia and hydrogen peroxide; under anaerobic conditions, however, there was neither ammonia nor hydrogen peroxide formation, and subsequent respiration and motility were unaffected. The ash of the substance had no appreciable effect on either respiration or motility. Spermatozoa inactivated by heat in presence of the substance and molecular oxygen produced neither ammonia nor hydrogen peroxide.

In view of the properties of the substance isolated, natural amino-acids were next tested individually as substrates for the metabolism and motility of bovine spermatozoa. This examination revealed that formation of ammonia and hydrogen peroxide, and subsequent inhibition of sperm respiration and motility, took place aerobically in the presence of only *l*-tryptophane, *l*-phenylalanine and *l*-tyrosine. There was neither ammonia nor hydrogen peroxide formation in the absence of oxygen or with heat-inactivated spermatozoa. The inhibition of sperm respiration and motility in presence of these substances was completely eliminated with added catalase (more than 10 μgm./4 ml. sperm suspension). In the presence of *dl*-alanine, *dl*-serine, *l*-cysteine, *dl*-valine, *l*-leucine, *l*-arginine, *l*-lysine, *l*-hystidine, *l*-aspartic acid and *l*-glutamic acid, there was no inhibition of either sperm respiration or motility, and no formation of ammonia or hydrogen peroxide.

These results suggest that the reaction by which hydrogen peroxide is formed by living spermatozoa is an enzymic dehydrogenation and deamination proceeding in the presence of molecular oxygen as hydrogen acceptor as follows:

$$R.CH_2.CH(NH_2).COOH + O_2 + H_2O \longrightarrow R.CH_2.CO.COOH + H_2O_2 + NH_3$$

where *R* can be only phenyl, *p*-hydroxyphenyl or indolyl groups, but none of the other groups tested. The *l*-amino-acid oxidase (or oxidases) of living bovine spermatozoa, which affects only the three aromatic amino-acids, appears to be, therefore, more specific than the *l*-amino-acid oxidase present in some other animal tissues, which can utilize as substrates a much larger range of *l*-amino-acids[3,4].

These findings may have an important bearing on the fertilizing capacity of spermatozoa, and on their storage and survival in storage media, such as egg-yolk, and in natural secretions, especially in view of the fact that *l*-tryptophane, *l*-phenylalanine and *l*-tyrosine are widely distributed in animal tissues and body fluids. Moreover, the spermatozoa have an exceptionally low capacity for decomposing hydrogen peroxide; and hydrogen peroxide, even in very low concentrations which have not so far been chemically detectable, has a detrimental effect on the respiratory activity and motility of spermatozoa, as demonstrated by the elimination of these effects in presence of added catalase.

This work, carried out on behalf of the Agricultural Research Council, will be published in detail elsewhere.

J. TOSIC

School of Agriculture,
University of Cambridge. Feb. 20.

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The Water-balance Principle of Crustacean Eye-stalk Extracts

IT has long been known[1] that extracts of crustacean eye-stalks contain a principle which not only influences the colour changes of crustaceans but also induces expansion of the melanophores in amphibians, acting in this respect like the intermediate lobe pituitary hormone. It was therefore of considerable interest when Gray and Ford[2] reported that extracts of crustacean eye-stalks produce an increase of water uptake in frogs similar to that observed after the injection of neurohypophysial extracts. No structure homologous to the vertebrate neurohypophysis has so far been identified in invertebrates; but the results of the American authors suggest the possibility that crustaceans, although they have no pituitary gland, elaborate pituitary-like hormones.

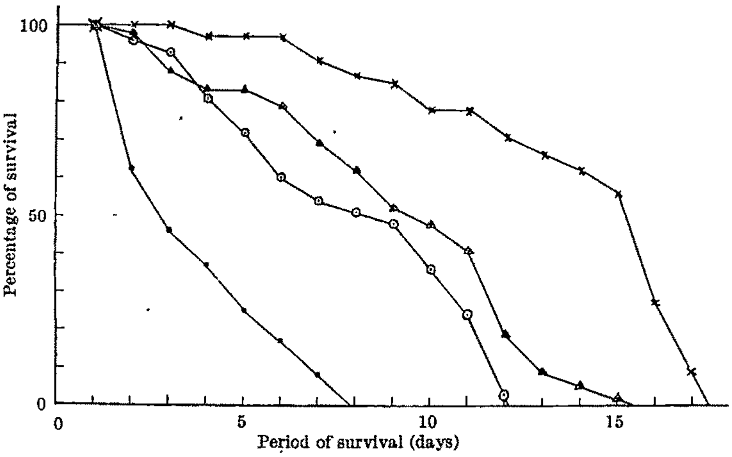

Fig. 1. VIABILITY OF *Echinorhynchus truttæ* IN DIFFERENT CONCENTRATIONS OF SODIUM CHLORIDE SOLUTION

●, 2 per cent sodium chloride. ×, 1 per cent sodium chloride.
▲, 1·5 ,, ,, ,, ,, ⊙, 0·75 ,, ,, ,, ,,

However, the similarity between the 'water-balance effect' of extracts of vertebrate pituitaries and that of extracts of crustacean eye-stalks is scarcely sufficient to characterize the eye-stalk factor as a pituitary-like principle. It was therefore decided to investigate whether crustacean eye-stalk extracts showed any of the other pharmacological actions of neurohypophysial preparations. Eye-stalks of the brackish water crab *Carcinus mænas* and of the fresh-water crayfish *Potamobius fluviatilis* were extracted according to the pharmacopœial method for the preparation of mammalian posterior pituitary extracts. Such extracts had a marked water-balance effect in frogs, but failed to give a significant pressor response in the spinal cat or an antidiuretic response on the unanæsthetized rabbit. Considering that most of the water-balance activity of mammalian neurohypophysial extracts is contained in the oxytocic fraction[3,4], the action of crustacean eye-stalk extracts on the isolated guinea-pig uterus was also examined. So was another action typical for the mammalian oxytocic fraction, namely, the action on the urinary chloride excretion in rats[5,6]. Negative results were obtained in both series of experiments.

No evidence could thus be obtained that the crustacean and the vertebrate water-balance factor are homologous principles; but although the water-balance activity of mammalian neurohypophysial extracts follows closely their oxytocic potency, it will have to be considered that this parallelism does not necessarily hold for non-mammalian pituitary extracts. For example, it has been shown[7] that frog pituitary extracts which per gland exerted a water-balance effect equivalent to that of 0·80 unit of the standard (mammalian) posterior pituitary extract, contained less than 0·04 unit of oxytocic activity. These results suggest that the vertebrate water-balance factor may have to be differentiated not only from the antidiuretic but also from the oxytocic pituitary hormone. It is therefore conceivable that a substance occurs in crustacean eye-stalk extracts which is related to the water-balance principle of vertebrate pituitaries but unaccompanied by any of the other neurohypophysial activities.

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Department of Pharmacology,
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Gray, S. W., and Ford, W., *Endocrin.*, **26**, 160 (1940).
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Acanthocephala of Trout and Anthelmintics: Behaviour *in vitro*

PRACTICALLY nothing is known of the *in vitro* behaviour of Acanthocephala to anthelmintics, and standard works[1-4] say little about treatment of these parasites *in vivo*. Although *in vitro* tests may possibly not reproduce exactly the response of helminth parasites *in vivo*, they give an opportunity of comparing directly the action of a large number of drugs in a shorter time; and results so obtained may suggest a method of combating Acanthocephala in the living host. With these objects in view the present investigation was carried out.

Echinorhynchus truttæ (Acanthocephala), a common parasite of the brown trout (*Salmo trutta*), was selected for experiment. The most active worms were used. Contact with metallic instruments and exposure to light were avoided, as these were found to have a deleterious effect on the parasites and hastened their death. In the survival experiments in various concentrations of saline, 288 individuals were used; and 330 in the experiments with various drugs.

The worms were kept alive in saline solution. According to Van Cleave and Ross[5], a 0·85 per cent sodium chloride solution is a suitable medium for maintaining the Acanthocephala of the turtle. For *Echinorhynchus truttæ*, however, a 1 per cent solution of sodium chloride appeared to be most suitable. In this solution the majority of the parasites retained their normal wrinkled appearance and survived for more than two weeks. In lower concentrations of saline the Acanthocephala became plump and showed bulging of the body cuticle, while in higher concentrations they assumed a more or less shrunken appearance; and in both cases the period of survival was considerably shortened (Fig. 1).

For testing the *in vitro* behaviour of the parasites to anthelmintics, a large number of experiments was carried out using different concentrations of various drugs which were suspended or dissolved in a 1 per cent sodium chloride solution. Control experiments were set up in each case. It was observed that certain anthelmintics, for example, carbon tetrachloride, thymol and copper sulphate proved fatal to the parasites at a concentration of 0·05 per cent and more (Fig. 2), while others, for example, santonin and sulphathiazole, did not produce any visible toxic effects even when used in a 1 per cent concentration. Oil of chenopodium usually killed the Acanthocephala if used at a concentration of at least 1 per cent; concentrations less than 1 per cent merely paralysed the parasites, which revived when afterwards transferred to a 1 per cent sodium chloride solution.

Without cytological examination it would be difficult to determine the exact nature of the damage caused by the anthelmintics to these Acanthocephala

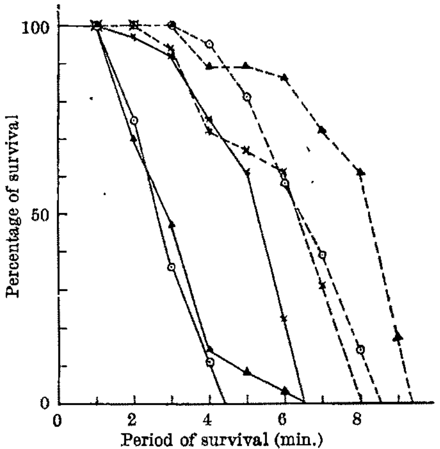

Fig. 2. VIABILITY OF *Echinorhynchus truttæ* IN 0·05 AND 0·1 PER CENT CONCENTRATIONS OF CARBON TETRACHLORIDE, THYMOL AND COPPER SULPHATE

.... 0·05 per cent. ⊙, carbon tetrachloride.
—— 0·1 „ „ ▲, thymol.
×, copper sulphate.

of the trout. The behaviour of the parasites, however, varied according to the drug used and its concentration. Both carbon tetrachloride and thymol brought about a rapid extroversion and introversion of the proboscis, accompanied by alternate expansion and contraction of the body. The movements were accelerated when higher concentrations of these drugs were employed. With these anthelmintics, the worms generally died in a fairly extended condition. Copper sulphate did not produce such marked effects, and with it there was scarcely any apparent difference in the activity of the Acanthocephala in different concentrations (0·05 per cent and 0·1 per cent solutions) except for a slight shortening of the period of survival in the higher concentration. With oil of chenopodium the worms showed a rhythmic expansion and contraction of the body, followed by a general wriggling movement. The body ultimately contracted and sometimes became S-shaped before the parasites finally became quiescent.

I take this opportunity of expressing my gratitude to Prof. James Ritchie for granting me facilities to work in his laboratory, and for the interest he has shown in my work.

M. B. LAL

Zoology Department,
University of Edinburgh. Jan. 7.

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"Criteria of Hybridity"

I REGRET that ambiguity in my article "Criteria of Hybridity"[1] has caused Prof. E. Anderson inconvenience. While discussing the 'index method' of investigating natural populations, I made the statement: "In the majority of cases known to the author where this method has been employed . . . its use has not been preceded by an artificial cross between the putative parent species, differences between those species being all that were known before the natural populations were investigated. The work of Goodwin . . . with *Solidago* is a exception."

By this statement it was intended to convey tha the references quoted were the cases known to m where the method had been employed, and that i the majority of them an artificial cross had not bee made. I feel that no one who is familiar with th excellent and extremely productive work of Anderso on the populations of *Tradescantia* in America will b unaware of the artificial crosses made and publishe by him[2] involving species concerned in two of th references (Anderson[3] (Section II), Anderson an Hubricht[4]). In any event such crosses are referred t in both publications.

Goodwin's work was picked out as exceptiona because it included a character-analysis of parent and artificial reciprocal crosses carried into the secon filial generation and including back-crosses to bot parents. In the remaining four papers quoted ther is no mention of artificial crosses having been mad prior to field investigations, and they are, therefor in the majority. In this amplification of my origina statement, it may be pointed out that Ownbey an Weber[5] do not, themselves, state that they hav used the 'index method' or publish keys, but I believ that reasoning of this sort was necessary to obtai the results which they report.

The quotation from Anderson[3] which appears i the same paragraph of my paper is taken from hi Section I ("A Method of Measuring Species Hybrids" which is not concerned directly with *Tradescanti* and the remarks made still stand, as the necessity fo prior experiment is not insisted upon in describin the method.

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[1] Baker, H. G., *Nature*, 159, 221 (1947).

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The Premaxilla and the Ancestry of Man

PROF. WOOD JONES' theory of human evolutio based on the premaxillary bone is, of course, wel known[1]. It depends on his assumption that it i legitimate to infer the phylogenetic antiquity of morphological character by noting the time of it ontogenetic appearance. However, attention is in vited to Ashley-Montagu's comprehensive study o the premaxilla of the primates[2], in which the autho reports that the apical portion of the premaxilla ma in some cases be observed on the facial aspect of th late fœtal and infant human skull, quite clearl separated from the maxilla by a distinct sutur I have recently had the opportunity of studying th original fossil Australopithecine material in Sout Africa, and gave particular consideration to th architecture of the upper jaw. There appeared to b no feature here which contradicts the conclusio put forward by Prof. R. A. Dart and Dr. R. Broo that the Australopithecinæ do indeed give ver important information regarding the primate for which were ancestral to *Homo*.

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Department of Human Anatomy,
University Museum,
Oxford. April 2.

[1] *Nature*, 159, 439 (1947).

[2] Ashley-Montagu, M. F., *Quart. Rev. Biol.*, 10, 32 (1935).

PROCEEDINGS OF THE PAN-AFRICAN CONGRESS ON PRE-HISTORY

A GENERAL account of the Pan-African Congress on Prehistory was published in *Nature* of February 15, p. 216. The following records the proceedings of the business meetings and supplements the former article.

Sixty-three papers were communicated to the Congress, and, in addition, four symposia were held, dealing respectively with "Pleistocene Marine Terraces", "Fossil Man in Africa", "The Hand Axe Culture in Africa" and "Fossil Apes in Africa".

Three sub-committees were set up to deal with problems relating to: (1) geology and general palæontology, under the chairmanship of Dr. S. H. Haughton; (2) human palæontology, under the chairmanship of Dr. A. Galloway; (3) prehistoric archæology, under the chairmanship of Mr. A. J. H. Goodwin.

A number of important resolutions, arising out of the deliberations of these committees, were placed before the Congress in its final session and duly passed. The most important of these dealt with the question of terminology in the African Continent, and, among other things, it was decided that in future:

(i) The Hand Axe Culture in Africa should be referred to as 'Chelles-Acheul' with suitable regional prefixes, instead of using such terms as 'Chellean', 'Acheulean', 'Stellenbosch', etc.

(ii) That the term 'Tumbian' should be abandoned, as well as 'Kalinian' and 'Djokocian', and that in substitution thereof the term 'Sangoan', with suitable definitive adjectives, be used for the earlier stages of the culture formerly described by the above terms, and the term 'Lupemban' for its later stages.

(iii) That the use of the term 'Aurignacian' for the blade and burin' culture in Africa be abandoned in favour of the term 'Capsian' with suitable regional prefixes.

(iv) That the use of the terms 'Clacton' or 'Clactonian' and 'Levallois' or 'Levalloisian' to describe *techniques* of working stone be abandoned, and that these terms be confined only to describing cultures and that the techniques should, in future, be described as 'block-on-block' technique and 'facetted platform technique' respectively, with suitable definitive terms where necessary.

(v) That the terms 'Kageran', 'Kamasian', 'Gamblian', 'Makalian' and 'Nakuran' should be used hroughout Africa to describe defined stratigraphical units, and based upon the established succession of faunas and deposits in East Africa.

Two permanent committees were set up to deal with the question of terminology in the fields of prehistory and quaternary geology respectively. It was decided that, in order to obviate the introduction of unsuitable terms into the literature of African prehistory, all workers should be invited to submit any suggested new names to the members of these committees for prior comment and advice. In this way it is hoped to avoid the creation of different erms for identical cultures in different parts of the Continent.

In its final plenary session, the Congress passed a number of resolutions addressed to Governments of countries in Africa, as well as to Governments of countries interested in research work of Africa, tressing the urgent need for further research work in the field of prehistory and quaternary geology, as well as human palæontology.

The Congress decided that, in view of the very important results achieved at this first Pan-African Congress on Prehistory, it was essential that the organisation should be set up on a permanent foundation. Rules and constitution were consequently drawn up and approved, and it was decided that a similar congress should be held at approximately four-yearly intervals.

While the Congress was in session, an official invitation was received from Field-Marshal Smuts for the Congress to hold its next meeting in the Union of South Africa in 1951, and this invitation was accepted.

The *Proceedings* of the Congress are now being prepared for publication, and many of the original papers that were communicated will appear in full. Advance orders for copies should be sent to the General Secretary, Pan-African Congress on Prehistory, P.O. Box 658, Nairobi, Kenya Colony.

RADIO-COMMUNICATION DURING THE WAR

AS already announced in *Nature*, the Radio Section of the Institution of Electrical Engineers held a Convention during March 25–April 2, at which about a hundred papers were presented describing the progress made in recent years in the subjects of radio-communication, broadcasting and certain types of navigational aids. The proceedings of this Convention, when published in the *Journal* of the Institution, will form a most useful record of war-time progress in radio research and development, complementary to that of the Radiolocation Convention held in 1946.

In his opening lecture on "Telecommunications in War", Sir Stanley Angwin gave some account of the remarkable achievements in this field in recent years, the success of which was undoubtedly due to very effective co-operation between the Government research establishments, the electrical and radio industry, and the Fighting Services.

The first three technical sessions were devoted to papers dealing with radio-communication over long distances and with the special problems encountered in the use of radio technique for military, naval and aeronautical communications. Owing to the limited range of radio frequencies which can be used for long-distance transmission, the band of frequencies allotted to each circuit must be used in the most efficient and economical manner possible. With this objective in view, considerable advances have been made in stabilizing the frequencies of radio-transmitters, in the use of single, in place of double, side-band modulation, and in the combined use of several adjacent narrow frequency channels keyed at a reasonably low speed for the purpose of sending messages between two points at very high speeds. In most forms of modern communication, whether for civil or military purposes, the radio-transmission path is merely a link connecting the land-line telegraph and telephone networks in the countries surrounding the terminal points. Recent developments have therefore taken account of the need for the systems of modulation adopted to be equally suitable for operating both the radio and land-line equipments.

In the application of communication to the modern very mobile army and to ships and aircraft, a number of severe limitations of space, size and weight are encountered; and the manner in which the corresponding electrical and mechanical problems have been solved were described in a series of papers dealing with this field. One of the outstanding achievements of the War was the development and use by the army of the No. 10 set, which, with a carrier wave-length of about 6 cm. and the use of pulse modulation technique, provides multiplex radio telephone facilities in an equipment of a highly mobile form. At the above wave-length the use of a large parabolic reflector gives a concentrated beam of radiation with a consequent high degree of privacy in communication. Although the effective range of each such set is in practice limited virtually to optical distances, the efficiency is such that many sets can be used in series; and it was in this way that Field-Marshal Montgomery was enabled to maintain direct telephonic communication with London during his advance through Germany.

While, as several papers described, the use of very high frequencies, corresponding to wave-lengths of a few metres and less, now plays an important part in communication, particularly for air-to-ground and other relatively short-distance operation, the bulk of long-distance communication is necessarily confined to those frequencies which are efficiently transmitted by reflexion from one or other regions of the ionosphere. In opening the session on "Propagation", Sir Edward Appleton described the British work on the exploration of the ionosphere during the past twenty years or more, and the manner in which such long-term measurements are applied to the prediction of average ionospheric conditions some months ahead. In a following paper, Messrs. K. W. Tremellen and J. W. Cox described the work of the Inter-Services Ionospheric Bureau, which was set up during the War to provide detailed forecasts of communication conditions as required from day to day for various parts of the world. The techniques thus evolved are being improved and applied to peace-time communication problems, the basic scientific work being carried out at the National Physical Laboratory under the auspices of the Radio Research Board of the Department of Scientific and Industrial Research.

At a later session, Mr. H. Bishop presented a paper in which he described the large and important part played by the Engineering Division of the British Broadcasting Corporation during the War. Very elaborate precautionary measures were initiated before the War, to ensure that the broadcasting stations in Great Britain did not provide navigational assistance to enemy aircraft, and these proved to be very successful in practice. In addition, the expansion and maintenance of adequate propaganda and information services to Europe and other parts of the world necessitated the provision of new transmitting stations of various types. As a result, Great Britain now has at Ottringham, near Hull, the highest-power medium-wave broadcasting station in the world, with an output power to the aerial of 800 kW. In addition, the world's largest short-wave broadcasting station has been erected at Skelton, in Cumberland, where twelve 100 kW. transmitters and a system of fifty-one aerials have been installed.

Other papers dealt with recent advances in radio direction-finding and certain types of navigational aids for ships and aircraft; and the Convention was brought to a close by a lecture by Sir Clifford Paterson in which he reviewed the work of all the sessions and indicated the direction in which future progress in this subject is likely to be made. Much of the war time experience will bear fruit in peace-time applications, particularly in connexion with civil aviation trunk telephony, broadcasting, television and the industrial uses of radio frequency and electronic techniques.

FLUORIMETRIC ANALYSIS

A DISCUSSION was held in the rooms of the Chemical Society, Burlington House, on February 11, by the Physical Methods Group of the Society of Public Analysts, on "Fluorimetric Analysis"

The first paper was presented by Mr. E. J. Bowen as a basis for discussion of apparatus design. It was argued that although on occasion visual methods might be valuable in revealing unsuspected or unwanted changes in the colour of the fluorescence photocell instruments have the advantage of simplicity of operation and high accuracy. The best design would seem to be a central lamp sending in opposite directions two horizontal light beams which are made parallel by lenses, monochromatic by filters, and controlled in area by diaphragms. The beams each traverse a rectangular transparent cell of solution, one a standard and the other the one to be measured. The fluorescent light emerging at right angles to the beams is received (through filters) by two photocells connected in opposition. The measurements may be made either by the direct differential output of the photocells, or by balancing this to zero electrically or by a calibrated variable diaphragm in one of the light beams. The advantages of vacuum type photocells with valve amplification over barrier layer cells for this purpose were stressed, and it was pointed out that the still greater sensitivities obtainable with photo-electron multiplier tubes make them very suitable for fluorimeters to measure feeble fluorescence, and open up some interesting new possibilities.

A second contribution by Mr. Bowen dealt with the theoretical aspects of the 'quenching' of fluorescence in solution. It was suggested that this term should be confined to the phenomenon of the non time-dependent weakening of the fluorescence of a substance below a 'fluorescence efficiency' of unity This would rule out effects caused by instrumental errors or by residual unwanted fluorescence in the solvent, cells, or filters. The use of the term 'fluorescence fatigue' to describe examples of reversible photochemical action was criticized. A systematic classification of quenching processes into three main types was presented: intramolecular energy rearrangements, intermolecular effects, and inner filter action. Experimental methods of distinguishing these types, and of the two kinds of intermolecular effects 'collisional' and 'compound' quenching, were described. The paper concluded with a brief account of the types of photochemical change often associated with fluorescent solutions.

Dr. E. Kodicek described precise methods he ha worked out for the fluorimetric analysis of such substances as riboflavine, vitamin A, etc., as a means o investigating nutritional problems.

Dr. D. M. Simpson (Cambridge) gave a shor account of the applications of fluorimetric analysis t the study of pterins. She emphasized the need fo the determination of standard spectra of synthetic pterins under controlled conditions of illumination and *p*H. At present such spectra are available only for xanthopterin and leucopterin.

Fluorescence spectra alone are insufficient to identify pterins in complex mixtures. Ultra-violet absorption spectra and chemical tests should also be employed. Using these complementary methods, it has been possible to demonstrate the presence of pterins in such diverse materials as the argentaffine cells of the stomach and intestine, the fluorescent substance obtained from the eye of the dog-fish (*Squalus acanthias*) and the 'uric acid pigment' prepared by heating uric acid and water in sealed tubes at 200° C.

Few quantitative determinations of the concentrations of pterins have yet been made using fluorescence spectra. Provided that suitable precautions are employed to avoid quenching and inner filter effects, the method should be feasible if synthetic material is available for comparison. Examination of a large number of liver extracts has suggested that the intensity of fluorescence might be used as a measure of the clinical activity of these preparations.

In discussion, Drs. Winch and Cooper described tests made with a G.E.C. photocell and valve with a grid-leak of 10^6 megohms, capable of detecting 10^{-11} lumens. The instrument can detect a concentration of 1 milli μ gm./c.c. of a fluorescent substance, below which the residual fluorescence or Raman radiation of the water interferes. Dr. Cooper criticized the use of double-beam instruments with a mercury lamp on account of the movements of the narrow arc thread with time. Dr. F. Wokes raised the question of temperature effects on fluorescence, and stressed the need for publication of adequate data on fluorimeter calibration in analytical papers. Dr. Ridyard welcomed clearer definitions of the term 'quenching' because of its relation to instrument design. He suggested that the device of a transparent glass plate at 45° to the beam to reflect some of the light might be a useful modification of the double beam arrangement. Dr. White suggested that a closer study of the types of quenching observed in different instances might prove a method of distinguishing substances with similar fluorescent emission. Dr. H. W. Thompson stated that the limiting factor of sensitivity in many fluorimeters is the fluorescence of the glass or gelatine filters used before the photocell. Drs. Griffiths, Gullerson and Ellinger also made interesting contributions to the discussion, which had been keen throughout and was brought to a close only by considerations of time and temperature.

RECENT SOLAR ACTIVITY

A PAIR of sunspots making a group of exceptional size crossed the sun's disk between March 31 and April 13 in lat. 24° south. The group was the return of that reported in *Nature* of March 22, p. 396, but meanwhile it had either grown or a new formation had developed, as seems more likely, giving an even greater area than during the first disk passage during March 3–17. This latest spot, with a peak area of about 5,400 millionths of the sun's hemisphere, now heads the list of the largest spots in the Greenwich photographic records begun in 1874–75. Even in the extended period covered by reliable drawings associated with Schwabe, Carrington and others, this spot probably holds its premier position for size. As will be seen from the list below, within fourteen months the largest four spots in the Greenwich record have occurred. For this alone, the present 11-year solar cycle will be remarkable, whatever further activity is in store during the next two or three years that should include the peak of spot-frequency of the cycle.

In one important respect, the latest spot has been surprising; no great magnetic storm, nor even a small one, occurred during the interval, two days before and four days after central meridian passage (April 6–8 U.T.), when great magnetic activity associated with big sunspots is most likely to begin. It is significant that available solar observations indicate an absence of marked chromospheric activity, especially intense solar flares, associated with the spot; but until central meridian passage few observations could be made in Great Britain owing to cloudy skies. However, radio data of fade-outs on short-wave long-distance transmission, as reported to the Royal Observatory, Greenwich, by Cable and Wireless, Ltd., entirely support the sampling from direct solar observation that no intense solar flare occurred over the spot when it was more nearly in line with the earth. Previous experience has shown that intense flares, such as those recorded with the two great sunspots of 1946, are synchronized by complete and prolonged fade-outs of an hour's duration or more on daylight circuits. The evidence for no intense flare will be virtually complete when similar data are obtained for daylight circuits during Greenwich night hours, in addition to solar observations made in America, Australia and India.

The list of giant spots that have exceeded 3,000 millionths of the sun's hemisphere on one or more days may now be given as follows. The areas given for the 1946 and 1947 spots are provisional only, pending the measurement at Greenwich of a completed series of photographs.

Year	Central meridian passage	Maximum area	Magnetic storm	
			Great or small	Begins
1947	April 6·8	5400	None	—
46	Feb. 5·5	4900	G	Feb. 7·4*
47	March 10·2	4300	s	March 8·3
46	July 26·8	3950	G	July 26·8*
26	Jan. 24·5	3716	G	Jan. 26·7*
38	Jan. 18·4	3627	G	Jan. 22·2*
37	Oct. 4·5	3340	s	Oct. 3·5
38	Oct. 11·9	3003	(s	Oct. 7·4)

An asterisk denotes that an exceptionally intense solar flare was observed in *Hα* (6563 A.) at one or more observatories at the following respective time-intervals preceding the beginning of the storm: 18, 26½, 24 and 29 hours.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, April 21

Institution of Electrical Engineers (at the Central Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. J. Hacking: "The Generation and Wholesale Distribution of Electricity" (Faraday Lecture).*

Society of Public Analysts and other Analytical Chemists, Biological Methods Group (in the West Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6 p.m.—Symposium on "The Production and Care of Laboratory Animals", Part 2. Dr. H. J. Parish: "Common Diseases"; Mr. N. T. Gridgeman: "Records".

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p.m.—"The Application of Statistical Control to Research and Testing".

Tuesday, April 22

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. A. J. Paul: "Photography in the Post Office".

Institute of Physics, Electronics Group (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. S. Rodda: "Electron Multipliers".

Wednesday, April 23

Physical Society (in the Physics Department, Imperial College of Science, Imperial Institute Road, London, S.W.7), at 5 p.m.—Discussion on "The Spark Discharge" (to be opened by Prof. Leonard B. Loeb).

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Miss Caroline Haslett: "Electricity in the Home".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. D. Gabor: "New Possibilities in Speech Transmission".

Society of Chemical Industry, Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting; Mr. T. Rundle: "Some Problems of Trade Effluent Disposal".

Tuesday, April 22—Wednesday, April 23

Institute of Physics, X-Ray Analysis Group (at the Royal Institution, 21 Albemarle Street, London, W.1).—1947 Conference.

Tuesday, April 22

"Training of X-Ray Crystallographers for Science and Industry". At 9.30 a.m.—"Requirements of Industry and Training by Industry"; at 2 p.m.—"Training of X-Ray Crystallographers in Polytechnics and Universities"; at 8 p.m.—Mr. H. P. Rooksby: "The Technique of X-Ray Powder Photography".

Wednesday, April 23

"New Techniques and Results". At 9.30 a.m.—"New Methods and Results of X-Ray Analysis"; at 2 p.m.—"New Industrial Techniques and Results".

Thursday, April 24

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. A. Todd: "Combinants of Pencils of Conics and Quadric Surfaces".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Miss J. G. Marley: "A Statistical Survey of Certain Aspects of the Beef Producing, Dairying and Cattle Rearing Industries in Great Britain between 1939 and 1945".

Institution of Electrical Engineers (at Kingsway Hall, Kingsway, London, W.C.2), at 5.30 p.m.—Prof. L. B. Loeb: "Electrical Discharge through Gases" (Thirty-eighth Kelvin Lecture).

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. J. W. Drinkwater and Mr. W. G. Glendening: "The Risk of Fire and Fire Prevention Methods".

Northampton Polytechnic (at St. John Street, London, E.C.1), at 7.30 p.m.—Mr. A. J. Philpot: "Scientific Instrument Manufacture and the Nation".*

Friday, April 25

Federation of British Industries (at the Merchants Hall, George Square, Glasgow).—Scottish Regional Conference on "Research and the Progress of Industry in Scotland". At 10 a.m.—"The Established Industries"; at 5.30 p.m.—"Balancing Scotland's Industries".

Society of Public Analysts and other Analytical Chemists, Polarographic Discussion Panel of the Physical Methods Group (in the Physical Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Dr. W. Cule Davies: "Remarks on Polarographs"; Dr. G. Jessop: "Notes on Polarographic Technique"; Dr. E. R. Roberts: "The Analysis of Brass Plating".

Chemical Society, Newcastle and Durham Section (in the Chemistry Lecture Theatre, King's College, Newcastle-upon Tyne), at 5 p.m.—Scientific Papers.

University College (at Gower Street, London, W.C.1), at 5.15 p.m.—Dr. J. F. Danielli: "Cell Physiology and Pharmacology" (other lectures on May 2, 9, 16, 23 and 30).*

Institution of Electrical Engineers (joint meeting of the Measurements and Transmission Sections, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Casson and Dr. F. H. Last: "Ultra-High-Speed Relays in the Fields of Measurement and Protection".

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. S. Timoshenko: "Stress Concentration and Fatigue Failures".

Society of Chemical Industry, Manchester Section (at the Engineers' Club, Albert Square, Manchester), at 5.45 p.m.—Annual General Meeting.

University College (at Gower Street, London, W.C.1), at 5.45 p.m.—Prof. R. O. Kapp: "The Presentation of Technical Information" (other lectures on May 2, 9 and 16).*

Manchester Statistical Society, Industrial Group (at the Manchester Society of Architects, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. E. D. van Rest: "Probability and the Experimenter".

Society of Dyers and Colourists, Manchester Section (at the Gas Department Showrooms, Manchester), at 6.30 p.m.—Dr. G. L. Royer: "Studies on Rayon Dyeing—Application of the Dyeometer".

Saturday, April 26

Association of Scientific Workers, North-West Area (at Milton Hall, Deansgate, Manchester), at 2.45 p.m.—Delegate Conference on "Industrial Health".

Institution of Chemical Engineers, North-Western Branch (in the Reynolds Hall, College of Technology, Manchester), at 3 p.m.—Mr. J. Maddock: "Process Costing and Cost Control".

APPOINTMENTS VACANT

Applications are invited for the following appointments on o before the dates mentioned:

Senior Scientific Officer in the Plant Breeding Divisio of the Ministry of Agriculture for Northern Ireland—The Assistan Secretary (Establishment), Ministry of Finance, Stormont, Belfas (April 25).

Lecturer in Physics—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants. (April 26).

Biochemist—The Secretary, Animal Diseases Research Association Moredun Institute, Gilnerton, Edinburgh 9 (April 26).

Teacher (graduate) of Mathematics, a Teacher (honours graduate) of Physics, and a Teacher (graduate) of Physics and Chemistry—The Principal, Acton Technical College, High Street, Acton London, W.3 (April 26).

Lecturer in Biology with subsidiary Chemistry, and Lecturer (2) in Chemistry—The Principal, Municipal College, Romford Road Stratford, London, E.15 (April 26).

Lecturer in Mathematics up to Higher National Certificat standard—The Principal, Handsworth Technical College, Golds Hil Road, Birmingham 21 (April 26).

Lecturer in the Electrical Engineering Department of th Croydon Polytechnic—The Education Officer, Education Office Katharine Street, Croydon (April 26).

Lecturer in Electrical Engineering—The Principal, Count Technical College, Dartford, Kent (April 26).

Graduate in Genetics, Agriculture, Veterinary Science o Physiology, for work involving abstracting and preparation of review—The Acting Director, Imperial Bureau of Animal Breeding an Genetics, King's Buildings, West Mains Road, Edinburgh 9 (April 28

Keeperships of the Departments of (*a*) Biology, (*b*) Antiquitie (*c*) Art—The Director, Museum and Art Gallery, New Walk, Leiceste endorsed with the appropriate words 'Keeper of . . .' (April 28).

Chair of Botany in the University of Tasmania—The Agen General for Tasmania, Golden Cross House, Charing Cross, London W.C.2 (April 30).

Director of Surveying—The Registrar, King's College, Newcastle-upon-Tyne (April 30).

Scientific Officer in the Blood Transfusion Service a Manchester—The Regional Blood Transfusion Officer, Royal Infirmar Manchester (April 30).

Wool Research Scholarship founded by the International Wo Secretariat—The Registrar, The University, Manchester 13 (April 30

Advisory Officer in Grassland Husbandry—The Secretar North of Scotland College of Agriculture, 41½ Union Street, Aberdee (April 30).

Lecturer in Bacteriology—The Secretary, King's College o Household and Social Science, Campden Hill Road, London, W. (April 30).

Assistant Lecturer in Botany—The Registrar, The Universit Leeds 2 (April 30).

Lecturer in Educational Psychology—The Registrar, Th University, Leeds 2 (May 1).

Tutor or Assistant Tutor in Biochemistry or Physiology—The Secretary, Somerville College, Oxford (May 1).

Assistant Physicist (full-time) in the L.C.C.'s Hospitals Service—The Medical Officer of Health (S.D.6), County Hall, London, S.E. (May 1).

Lecturer in Mathematics—The Registrar, University Colleg Singleton Park, Swansea (May 3).

Lecturer in Civil and Mechanical Engineering, and a Lecture in Workshop Processes—The Clerk to the Governors, Woolwic Polytechnic, Woolwich, London, S.E.18 (May 3).

Principal Agricultural and Horticultural Officer an Principal of the Farm Institute—The Director of Educatio Shire Hall, Nottingham (May 3).

Lecturer in Physics, a Lecturer in Chemistry (with speci qualifications in physical chemistry), an Assistant Lecturer I Mathematics (pure or applied), and an Assistant Lecturer I Chemistry—The Principal, Royal Holloway College, Englefie Green, Surrey (May 3).

Official Fellowship and Lectureship in Chemistry—Th Rector, Exeter College, Oxford (May 3).

Lecturer in Textile Testing in the Department of Texti Industries—The Registrar, The University, Leeds 2 (May 5).

Associate and Full Professorships in the Department O Physics—The Head of the Department of Physics, University British Columbia, Vancouver, B.C., Canada (May 12).

Assistant Lecturer in the Department of Geography An Anthropology, with special qualifications in Cartography—Th Registrar, University College of Wales, Aberystwyth.

Speech Therapist—The County Medical Officer, County Ha Hertford.

Senior Lecturer in Physics—The Clerk to the Governors, Wolverhampton and Staffordshire Technical College, Education Offices, Nort Street, Wolverhampton.

Assistant Lecturer in Horticulture—The Registrar, Universit College, Exeter.

Laboratory Technician (Grade B) in the Department O Physiology—The Warden and Secretary, London (Royal Fr Hospital) School of Medicine for Women, 8 Hunter Street, Londo W.C.1.

Physicist to the Radiotherapy Department—The Secretar Superintendent, Royal Sussex County Hospital, Brighton.

Chemists (men and women, temporary) in the Chemical Inspectio Department of the Ministry of Supply—The Ministry of Suppl Est. 5 (B) 2, Room 828, Adelphi, London, W.C.2, quoting Chem. 6

Technician (Grade A) for the Regional Serological Referenc Laboratory (Ministry of Health), Oxford—The Director of Patholog Radcliffe Infirmary, Oxford.

Head of the School of Pharmacy—The Clerk and Treasure Dundee Technical College, Bell Street, Dundee.

Physicist or Engineer for research into problems of lace manufacture—The Research Officer, Lace Federation Research Counci 71 Upper Parliament Street, Nottingham.

Indian Science News Association
Office of Science & Culture
Calcutta

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FURTHER EDUCATION

BOTH the significance of the further education of young people and adults in Great Britain and the magnitude of the organisational problems which are involved in the creation of a national scheme are emphasized in the Education Act, 1944. The responsibility of local education authorities is clearly defined—"to secure (i) full-time and part-time education for persons over compulsory school age; (ii) leisure-time occupation, in such organised cultural, training and recreative activities as are suited to their requirements, for any persons over compulsory school age who are able and willing to profit by the facilities provided for that purpose". It has, however, become increasingly clear that the discharge of such a responsibility by local education authorities requires more than the provision of teachers, buildings and equipment. Not only does it involve an assessment of the educational needs of the community and presuppose, as the Education Act acknowledges, a close relationship between local education authorities and many local interests; it also implies a change in the functions of these authorities and in their relationship to each other.

So long ago as February 1946, the Ministry of Education accepted the view that "the organisation of further education must be on a regional basis if all the needs of industrial and commercial personnel are to be covered adequately". Efforts have, in the past, been made to solve this difficulty in Yorkshire by the establishment of a Regional Council of Further Education, and in Lancashire, North and South Wales, and the Midlands by similar councils. This trend towards regional co-operation received a new impetus and significance when the Percy Committee on Higher Technological Education recommended that Regional Advisory Councils should be established throughout the country "on the general lines of those now in existence in some areas", and that, "as an integral part of the regional machinery, Regional Councils should create Regional Academic Boards of Technology composed of academic heads of universities and technical colleges and members of their teaching staffs".

Although these recommendations were accepted in principle by the Ministry of Education, there are few signs that the implementation of the report of the Percy Committee is being regarded as a matter of urgency. This is clearly indicated in Circular 133 of the Ministry of Education. In directing local education authorities to prepare and submit their development plans for further education not later than March 31, 1948, the Minister reminds them that they must have regard to facilities for further education provided in their areas by universities, educational associations and other bodies, and to consult such bodies and local education authorities for adjacent areas. It is assumed, adds the Minister, that local education authorities will work in close touch with the regional councils for further education; but, because such councils have *not* been universally established throughout the country, he has been compelled to add that he will require assurance from some authorities that they have complied with the requirements of the Education Act regarding consultations.

It is therefore not surprising that the Ministry has issued a provocative and suggestive pamphlet* "designed to survey the whole field of further education as an entity, in order both to indicate the part which each feature of it should play in relation to the whole and to suggest possible lines of future development". Still less is it surprising, on account of the tardiness of local education authorities in establishing regional committees, that the emphasis should be upon regional co-operation. Much of it is, indeed, written in elucidation and explanation of the views expressed in Circular 87. On grounds of economy it would be improper, particularly in the higher range of studies, for each local education authority to attempt to provide for all the needs of students living in its area. Nevertheless, economy is not the only factor in regional organisation. There are many positive functions which a regional body can usefully perform; these include the planning of new developments, the expansion of existing facilities, the review of courses and curricula, the most effective use of specialist staff. "To a special degree, our fortunes to-morrow depend upon the extent to which our plans for technical and commercial education are placed to-day in the forefront of our reconstruction programme, and the vigour and vision with which they are carried through."

The deeper significance of the pamphlet lies in the interpretation of this generalization—the conception of further education as an entity. There is the realization that the planning of technical and commercial education is only a part, however important, of a larger task. The immediate responsibility of local education authorities is to assume leadership in the co-operative enterprise of community education; and such education is defined as embracing both skill and social leadership. In addition to possessing the technical knowledge required to meet the highly specialized demands of industry and commerce in a scientific age, men and women must, it is postulated, have an understanding of everyday human relationships. "Industry to-day is a large-scale social organisation and success in it will depend upon qualities of personality no less than upon acquired knowledge." To a very much greater extent than in the past it has, therefore, become necessary to foster corporate life and to extend the range of students' interests and social powers.

Whether, or to what extent, local education authorities will be able to unify work in the field of further education must remain speculative. It should, however, be noted that the Education Sub-Committee of Nuffield College† recently expressed the view that, without seeking to minimize the truly educational work done in technical colleges, philosophy, history, literature and pure science should be recognized as having their own sphere. "'Organised cultural training' is," the statement continues, "in the Education Act put with 'recreative activities' as coming under leisure-time occupation. A further link between these is forged by the Government pamphlet on Community Centres." It is, however, significant that the Ministry has not only organised one department to deal with technical education and "organised cultural training and recreational facilities", but has also indicated to local education authorities that "since, in many areas, the requirements for compulsory part-time education will be within the premises of a single college planned to meet local needs of further education—both compulsory and voluntary—it is essential to regard the requirements of Sections 42 and 43 as part of an integrated whole".

What would, consequently, seem to be indisputable is that local education authorities must, in preparing their plans for further education, give as much consideration to the potentialities of the individual man and woman as to the types of studies and activities to be provided. There are at least two lessons to be learnt from war-time experiences in H.M. Forces. First, the number of people who are ready to take advantage of formal educational activities (other than those which are purely vocational) is relatively small. As Sir Richard Livingstone has said, in paying tribute to the work of the Workers' Educational Association, "it is remarkable until you remember that there are forty-three million people in this island". Secondly, there is reason for believing that a high percentage of the majority who are repulsed by formal education are attracted to informal activities and responsibilities which are shared appropriately among all concerned; and it is of the greatest importance that these men and women should not seek in vain for opportunities to pursue similar interests in civilian life. If the individual is to be socially adequate in a constantly changing world, he requires adaptability and flexibility towards personal and social no less than towards economic and vocational problems.

For this, if for no other reason, it is perhaps fortunate that the difficulties to be overcome are not wholly organisational. Much will obviously depend on the concept of education possessed by those who specialize in work among young people and adults. There are, happily, increasing indications that the compartmental concept of education is being replaced by the integral. In an earlier age educational practice was undoubtedly over-compartmental and, in consequence, society-blind. It either could not see, o failed to admit, the existence of society and the relationship of the individual to it as a relevant factor in human affairs. That it is being replaced by the integral concept is, in large measure, due to the pioneer work which has been done in adult education, the acceptance of the principle that education is a life-long process and the realization that society is, or can become, an educational agent. "The lif of Man is," as A. N. Whitehead has written, "founde on technology, science, art and religion;" and it is the ideal of the good educationist to look to the whole man—the good man, the good citizen, and the usefu man.

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* Further Education. (H.M. Stationery Office.) 2s. net.

† The Further Education of Men and Women: a Task of the 1944 Education Act. (London: Oxford University Press.) 1s. net.

How necessary the acceptance of this ideal has become may be illustrated simply. The achievements of modern technology have been part of a culture of which the central theme has been the seizure and exploitation of power and the increased use of non-human sources of energy. What concentration on the development of this culture has, however, tended to obscure is that, the more energy man commands, the more important it is that this energy should be at the service of his whole personality, and not merely at the command of some narrow ambition or some limited goal. So far as science and technology have been wedded to narrow concepts of human development and human well-being, they have given power to military, political, and financial despots, they have fed their egos and justified their ambitions, they have further brutalized the brutal and corrupted the corrupt. They have, in a variety of ways, disintegrated the life of man by making him the victim of the machine rather than its commander and controller.

Men do not live by machines alone, and the power impulse, however deep and ineradicable, is neither self-sustaining nor self-sufficient. Machines are not—and never can be—a substitute for vital human needs, many of which are frustrated by over-emphasis on the quantitative and mechanical. The hiatus which now exists between those parts of life which have become controlled by machines, and those parts which lie outside their scope, constitutes one of the gravest problems of contemporary society. Nothing less than the autonomy of the human personality is at stake, and it cannot be saved unless the social context in which man has to act and to survive is given adequate attention.

FOSSIL MAN

Les hommes fossiles

Éléments de paléontologie humaine. Par Prof. Marcellin Boule. Troisième édition par Henri V. Vallois. Pp. xii + 587. (Paris: Masson et Cie., 1946.) 1200 francs.

SINCE it first appeared a quarter of a century ago, Boule's treatise on fossil man has become one of the recognized classics of human palæontology. It has been particularly noted for the clarity of its exposition and for its very fair summarization of the sort of evidence (often sparse and difficult to interpret) upon which palæontologists have to rely. It was primarily also a personal exposition, reflecting the results of the author's original observations and his own assessment of the evidence presented by others. Between 1934 and 1939, Boule worked on the revision of his book for a third edition, and during this time had completed the first eight chapters (that is, more than half the volume). It had been his intention to complete the revision on his retirement; but the outbreak of war and his death soon afterwards prevented this. However, the task has been undertaken by his colleague, Prof. Vallois, than whom no better qualified editor could probably be found.

No doubt the main difficulty of the editor must have been to give adequate expression to the wealth of new discoveries bearing on prehistoric man which have been made during the last few years. But Prof. Vallois has taken the wise course of retaining the individuality of Boule's classic book even at the risk of leaving it somewhat unbalanced as a representative account all the additional evidence relating to the evolution of *Homo sapiens* which has quite lately become available. On the other hand, all the most recent evidence is included by reference, even though in some cases it may not be treated in the detail which its importance might seem to require.

Boule's was clearly a 'master mind' in the sense that he had an intimate knowledge of details and at the same time a really comprehensive grasp of the subject of human palæontology as a whole, and it is worth while considering his main conclusions concerning some of the more obscure problems which still provoke controversy.

As regards 'tertiary man', in so far as the solution of this problem depends on eoliths the author expresses himself with extreme caution. He definitely rejects the evidence which was presented so forcibly by Ray Lankester and Reid Moir, and in regard to other evidence he concludes that we have no infallible means of distinguishing the fortuitous natural chipping of 'eoliths' from the products of an intentional handiwork which in any event was extremely crude. The osteological evidence provided by all the *Pithecanthropus* material now available from Java, and also the remains of Pekin man, is considered at length, with the general conclusion that they should be grouped together as "Préhominiens", indicating their ancestral relationship to Neanderthal and modern types of man. The author emphasizes very strongly the close relationship of the Javanese and Pekin fossils, and insists that the differences between them have at most a specific (and certainly not a generic) value. This conclusion is in full accord with the view now commonly adopted by palæontologists that the original nomenclature of Davidson Black, *Sinanthropus pekinensis*, should be replaced by *Pithecanthropus pekinensis*.

The discussion of Neanderthal man occupies a relatively large portion of the book, as might be expected from a consideration of Boule's classical study of the almost complete skeleton found at La Chapelle aux Saints in 1908. The view is taken that *Homo Neanderthalensis* was essentially a specialized and somewhat aberrant form which became extinct and played no part in the evolutionary development of *Homo sapiens*. This interpretation also now receives wide accord, and, indeed, it could scarcely be otherwise since the accumulation of evidence provided by the Ehringsdorf, Steinheim and Swanscombe skulls, to say nothing of other evidence (including that from East Africa) which indicates the existence of *Homo sapiens* in pre-Mousterian times. The negroid affinities of the Aurignacian skeletons from Grimaldi are accepted; but the strong arguments which have been adduced for the Eskimoid nature of the Magdalenian skeleton of Chancelade are vigorously contested. Lastly, Cro-Magnon Man is believed to survive still in parts of the Dordogne and in the population of the Canary Islands.

A phase of human palæontology which receives inadequate treatment is that represented by the now famous Australopithecine fossils of South Africa. These important discoveries are quite cursorily dealt with in scarcely more than three pages and, although it is conceded that they are the most human of fossil apes which have so far been discovered, they are given no particular place in the theme of human evolution. Had Boule lived long enough to learn the mass of evidence regarding these remarkable fossils which has accumulated during the last few years, and particularly if he had been able to read the monographic study on the Australopithecinæ recently published by Dr. Robert Broom, there is little doubt that he would have recognized their importance by devoting much more space to their consideration.

An interesting feature of this new edition is the fact that more than 130 pages are now occupied with discussions of the remains of fossil man and his cultures which have been discovered in other parts of the world besides Europe—India, Malaya, Oceania, Australia, Africa, North America and South America. This is interesting as an indication of the increasing attention which is being directed to archæological research outside Europe. It may be surmised that in a future edition the geographical balance will be altered still further, for it is becoming more and more clear (particularly as the result of recent discoveries in the African continent) that the early palæolithic populations in Europe may have been little more than the 'stragglers' of much larger and more highly organised communities which were responsible for developing the characteristic palæolithic cultures in parts of the world less disturbed by gross climatic fluctuations. It is perhaps scarcely necessary to add, of a book so well known in its previous edition, that the illustrations are both excellent and numerous. W. E. Le Gros Clark

BIOLOGY OF CARCINOGENESIS BY CHEMICAL COMPOUNDS

Les cancers produits par des substances chimiques exogènes

Par Prof. Antoine Lacassagne. (Radiophysiologie expérimentale cancer et hormones, 5 : Actualités scientifiques et industrielles, 1003.) Pp. 166. (Paris : Masson et Cie., 1946.) 150 francs.

THIS monograph by Prof. Lacassagne is one of a group which will cover the subject of carcinogenesis and deals with the production of cancer by chemical substances. In the first chapter the author discusses arsenical cancer. Arsenites were indicted as carcinogenic agents so long ago as 1820, but no unequivocal evidence has ever been produced to show that arsenic is carcinogenic. No reference is made to Prof. E. L. Kennaway's discussion of this part of the subject under the title of "A Contribution to the Mythology of Cancer Research" (*Lancet*, 2, 769; 1942); but this paper may not have been available in Paris when the monograph was written. Although arsenites have not been shown to be carcinogenic in experiments on animals, they are mitotic inhibitors belonging to the class of radiomimetic poisons which also includes some of the vesicants. The relation between mitotic poisons and carcinogens is still obscure, but urethane is a carcinogen which inhibits mitosis.

The second group of substances considered are the nitrogen-containing polycyclic compounds which have been of interest since 1906, when it was shown that cancer of the bladder occurred abnormally frequently in workers handling fuchsine and naphthylamine. Cancer of the bladder has been induced experimentally in animals by three substances: β-naphthylamine, *o*-aminoazotoluene and 2-acetylaminofluorene. Some aromatic nitrogen compounds such as 2 : 2′-azonaphthalene, 2 : 2′-diamino-1 : 1′-dinaphthyl and 4-dimethylaminoazobenzene are able to induce cancer of the liver. The action of this type of compound on the liver is dependent upon the diet on which the experimental animals are maintained, the incidence of cancer of the liver being much higher in animals maintained on 'poor' or low protein diets. This may be connected with the high incidence of cancer of the liver in communities such as the Bantus and Japanese, where low protein dietaries are common. The author points out how the compound Styryl 430 is unique in being a water-soluble aromatic carcinogenic compound. Finally, the nitrogenous carcinogens include substances resembling the carcinogenic hydrocarbons in which a carbon atom is replaced by nitrogen as in the benzacridines and dibenzcarbazoles. One of these, 3 : 4 : 5 : 6-dibenzcarbazole, forms a link in that it is capable of producing tumours at the site of application as the hydrocarbons do, and also producing cancer of the liver like many aromatic amines.

The last hundred pages of the book are devoted to the carcinogenic hydrocarbons from the point of view of a biologist rather than from that of a chemist, as the chemistry of carcinogenesis will be discussed in a separate volume by Prof. N. P. Buu-Hoï. The general rules relating carcinogenic activity and chemical structure are indicated, but the emphasis is on the history of the subject and the biological experiments. Advances in our knowledge of biological actions are often dependent on methods of testing. Methods for testing carcinogenic activity were first developed in Japan, but used to great effect by European workers, particularly by research workers at the Royal Cancer Hospital, London. A carcinogenic substance was isolated from coal tar, and a large number of synthetic hydrocarbons shown to be able to produce cancer on the skin of mice. Coal tar is usually too toxic to be used for injection into the body, but the preparation of pure carcinogenic hydrocarbons made it possible to produce cancer of many organs in different species of animals. Prof. Lacassagne refers to injection as "la méthode américaine", in contrast to painting the skin with the carcinogenic substance or "la méthode anglaise".

Experiments carried out in many laboratories have shown that tissues and species of animals differ widely in their susceptibility to carcinogenic substances. The epidermal and connective tissues are the most sensitive, and the alimentary tract is relatively resistant. Tumours have been induced by carcinogenic hydrocarbons in mammary glands, testes, kidney, liver, prostate, brain, lung, salivary glands and connective tissue. A separate chapter is devoted to the induction of tumours of the alimentary tract and of the lung. These two sites are of great importance from the point of view of human cancer, but attempts to produce tumours of the stomach or lung in animals by hydrocarbons have given most erratic results. The tumours of the stomach which have been induced in mice are not comparable with gastric cancer in man. This is a part of the subject which requires much more investigation before the carcinogenic process is understood. The application of carcinogens to the blood-forming organs either directly or by injection of circulating carcinogenic substances leads to leucæmic changes which may be malignant and vary enormously in type.

The whole review, written by a leading worker in the field, forms an interesting discussion of the effects in different species and in animals of different genetic constitution, of carcinogenic substances in various media administered by divers routes. E. Boyland

Racial Pride and Prejudice

By Eric John Dingwall. Pp. x + 246. (London: Watts and Co., Ltd., 1946.) 8*s.* 6*d.* net.

THIS book deals with an important world problem from the point of view of the anthropologist and the psychologist. It is intended for the general reader rather than the student of either of these sciences, and Dr. Dingwall is to be congratulated on the way he has managed to avoid technical language except where it is absolutely necessary. The book has another great advantage in that the author is not only content to present the facts as he sees them, but also does not hesitate to insert short discussions of the possible reasons that lie behind customs and legislation associated with the colour bar. The combined presentation makes admirable reading. It is unnecessary in a notice of this character to stress the sane, but nevertheless realistic, point of view of the author; it would be more appropriate to direct attention to other special merits that the book possesses. One of these is the admirable psychological approach to the problem of prejudices in general and colour prejudice in particular, and Chapter 14 on the psychology of racial and colour prejudice is a masterful essay in itself. The reader is impressed particularly by the part that jealousy plays in this respect.

To the geography student the book has yet another distinct advantage in so far that the treatment is global. There are chapters on the colour bar in the United States of America, Great Britain, Africa, the West Indies, India and the East, Brazil, Australia and New Zealand, and the U.S.S.R. Such a complete world survey is admirable and will be much appreciated by the student of human geography. The author states in his preface that references and footnotes have been cut down so far as is possible in a book of this kind, and that if authority were to be quoted for every statement the bulk of the book would be almost double and its value would not have been increased in proportion. Nevertheless, the addition of a few well-selected maps showing, for example, the distribution of the Negro population in the United States, or the white population in the Union of South Africa, would be most welcome. The general reader, for whom this volume was written, is ignorant of these essential facts, and while the addition of a few distribution maps would not have made the volume more bulky, it would have increased its value very considerably.

E. G. BOWEN

Introductory College Chemistry

By Prof. Harry N. Holmes. Fourth edition. Pp. x + 590. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1946.) 18*s.* net.

THIS very attractive book is now in a fourth edition and has been considerably revised. Although its title, and the statement in the preface that it "is of full college grade", suggest a moderately advanced book, it is really of a standard that would be used in schools in England, and in many parts does not reach Higher School Certificate level. The charts and illustrations are often suitable only for very immature students.

The sections on the metals are dispersed, group methods of preparation and group reactions being stressed. The physical chemistry is presented in some detail, and there are whole chapters on the structure of the atom and nuclear chemistry. Chapters on organic chemistry include matters of technical interest or of importance in daily life, such as hydrocarbons, rubber, carbohydrates, plastics, and food and nutrition. There are references to literature (including some English journals) and questions. In many cases the information is very slight: the only property of carbon disulphide (which has five lines of text) mentioned being that "one pound is needed in the manufacture of three pounds of viscose rayon". The sections on selenium and tellurium, on the other hand, extend over nearly two pages. The validity of the formulæ of orthonitric acid on p. 303, with 5-valent nitrogen, is doubtful. Mercurous compounds are formulated with univalent mercury. These are minor points; generally the text is very clear and accurate.

What will interest most readers is the very large number of out-of-the-way and striking facts which are worked into the text; teachers should find many of these likely to stimulate interest. Although the book is not suitable for English school courses, and is much too elementary for junior university use, it is one which can be recommended as likely to be popular in a school library and useful to the teacher. The production is excellent and the price, although rather high for its size, is not prohibitive.

The Scottish Railway Network

A Project for Reconstructing the Scottish Railways according to certain New Railway Network Principles. By J. F. Pownall. Pp. 72. (Birmingham: Cotterell and Co., 1946.) 8*s.* 6*d.*

IN this small volume Mr. Pownall returns to an exposition of his hour section principle which he outlined in his "New Railway Network Principles". The present volume deals with Scottish railways. The central idea is that full value cannot be derived from most railway lines because, in spite of good speeds, continuity of movement is hampered. The author would ensure fast journeys on the trunk lines, and the more important branch lines, by recognizing certain "hour stations" on all important routes. Some of these would be stations of present importance to-day, others of little importance and others new stations. Expresses would call at these stations and these only, at precise hour intervals, and connect with slower intermediate trains. Several new lines would be necessary. The scheme is ingenious and deserves consideration in any plans for the modernization of the railways of Great Britain.

The Faroes in Pictures

By Gordon Huson. Pp. 82. (London: George Allen and Unwin, Ltd., 1946.) 10*s.* net.

THE Faroes are little more than a group of huge volcanic rocks reaching to heights of several thousand feet above sea-level. They lie on the Faroe-Icelandic ridge 200 miles from the nearest land, which is Scotland. Rainy, windswept and infertile though the islands are, their growing population numbers nearly thirty thousand and is fairly homogeneous of early Norse descent. Only three per cent of the land area is cultivated, and most of that is used for sheep grazing. The main occupations are fishing and whaling. The comparatively small caaing or grind whale is caught in numbers. Little in English has been written on these Danish islands. The exigencies of war led to a British garrison, and Major Huson, who was in that garrison, has produced a charming and useful book of pictures to which is attached a very brief account of the islands. The pictures give an excellent idea of the land forms and the surface conditions.

THE LATE-GLACIAL PERIOD

By P. TALLANTIRE and S. M. WALTERS

Botany School, Cambridge

A DISCUSSION on "The Survival and Extinction of Flora and Fauna in Glacial and Post-glacial Times: the Problem Viewed in Relation to Quaternary Historical Investigations" was held by the British Ecological Society at a meeting in the rooms of the Royal Society on October 15, 1946. The president of the Society, Dr. A. S. Watt, pointed out that it was eleven and a half years since the same rooms had witnessed the Royal Society discussion on the "Origin and Relationships of the British Flora". Although there were a number of contributions from pollen analysts in the original discussion, the emphasis had now shifted towards the lines of evidence that they could supply. This meeting was one of a number then being held in connexion with a conference for Quaternary history in north-western Europe.

The first speaker, Prof. K. Jessen, of Copenhagen, said that in previous discussions, as for example at the Royal Society in 1935, all shades of opinion had been represented, from 100 per cent extinction of the British flora and fauna at maximum glaciation, with subsequent immigration, to 100 per cent survival. The real need was for reliable evidence based on actual, macroscopic remains of the plants and animals in question, particularly thermophiles, in glacial and late-glacial deposits. These evidences are few at present, and somewhat idle speculation correspondingly excessive. He gave a résumé, with slide illustrations, of the probable course of the late-glacial vegetational development in north-west Europe, and possible climatic inferences. Commencing with his three late-glacial periods: I. Older *Salix*; II. Allerød; III. Younger *Salix* time: distinguishable in Denmark, north-west Germany, and Ireland, he tentatively equated the Younger *Salix* period with the formation of the Salpausselka moraine stage of the Scandinavian ice-retreat. Subsequent developments were considered to be post-glacial.

A distribution map for period II showed 'tundra' in North Denmark, 'park tundra' to the south, and the northern border of pine and birch forests in South Baltic regions. In Ireland there was 'tundra' over most areas, possibly *Empetrum* heath in the north and north-west. The forest northern border definitely lay well south of Ireland, but so far its position was unknown for England and Wales. He stressed the difficulties of characterizing the vegetation zones by names, since the conceptions, for example, 'tundra', varied considerably in different regions. 'Park tundra' was intended to connote a tundra vegetation with patches of bare moraine, patches of dwarf salices, *Betula nana*, *Dryas octopetala*, etc., and occasional copses of larger birch species in favourable localities. In Zone III certainly no woods were suggested, as evidenced both by the absence of macroscopic remains of tree-birch, there being only one certain locality for this type of birch in Ireland in the Younger *Salix* period.

Late-glacial sea-levels were known to have been as much as two hundred metres lower than present ones, so that former land-connexions, for example, England to Ireland, Ireland to Spain, and the former southward extension of land in the Solent region in England, may have existed and may possibly have borne forests, for example, of *Arbutus*, in an oceanic wood flora to the west of Cornwall, as has been suggested (by Du Rietz).

The difference between vegetational development in Ireland and in Denmark was considered due, then as now, to more oceanic climatic influences in the west. The pattern of post-glacial development is parallel in the two countries. In the first post-glacial zone, Zone IV of Jessen, birch (*Betula pubescens*, agg.) enters in large amount and has an over-all dominance; pine is very insignificant both in the pollen curves and macroscopically. Large willow species are frequent. At the same time, there is an immigration of thermophile aquatic species in both countries, for example, *Ceratophyllum demersum*. In Zone V, with birch dominance and a spread of hazel, there occurs the first certain evidence for pine, although still in small amounts. In Zone VI*a*, with an astounding hazel preponderance, the two species of *Naias* appear in Ireland, having been present in Denmark in Zone V as well; *Naias marina* represented in a few localities, *N. flexilis* in slightly more. The hazel maximum phenomenon, with traces of mixed oak forest (*Quercus* + *Tilia* + *Ulmus*), is observable all over north-western Europe. Its meaning or contemporaneity are both so far unknown. Uncertain, too, is the pine maximum, in the Boreal Zone VI*b* in the west of Ireland but delayed until VI*c* in the north-east.

Since *Naias flexilis* occurs in Ireland at the present day, its presence in Zone VI may indicate that it is a survival species, at least, that is, indigenous and not re-introduced by human agency. A similar point was made for *Eriocaulon septangulare*, the pollen of which is found in Zone VII*a* at Roundstone, a present-day west Ireland locality as well. Three *Erica* species occur in the Roundstone deposits—the Atlantic species *E. cinerea* from Zones V and VI, *E. tetralix* from Zones V–VII*a*, and one of the Lusitanian species, *Erica Mackaii*, macroscopically identified from leaves, from Zones VI and VII*a* and from inter-glacial deposits in the west of Ireland. The present distribution of *E. Mackaii* is Portugal, north Spain, and a few localities in western Ireland apparently as in Boreal times. It is absent from France.

Dr. Jessen concluded by saying that survival and subsequent immigration of species in Denmark was believed to have centred on south-east and south-west Europe. The speed of immigration had been no quicker in Ireland, thus it seemed unlikely that the Irish species survived so close to Ireland as the debatable southern land surface towards the Bay of Biscay.

Dr. J. Iversen, of the Danish Geological Survey, spoke next on some steppe elements in the Danish late-glacial flora and fauna. The first indications of such an element were encountered in the 1800's when Steenstrup described the ground squirrel (*Spermophilus rufescens*) in a late-glacial freshwater deposit. More recently plant evidence has come to light, and other faunal remains can be roughly dated by pollen analysis methods. Late-glacial finds, in the so-called reindeer period, comprise surprisingly few 'arctic' forms, including only a skull of a mouse hare (*Lepus timidus*) and a jaw of the glutton. Even these, together with the reindeer, are not solely restricted to an arctic–alpine range but may penetrate the forest belt. Steppe forms have an equal frequency. Time and distribution maps were shown for the bison and wild horse from late-glacia and preboreal periods, one find each of the ground-squirrel and mouse have been made from the late-glacial, and four finds of the Irish giant deer dating from the late-glacial and early Allerød. The latter may represent a third, woodland, element restricted to the milder Allerød and post-glacial periods in Denmark. Similarly in north-west Germany, at Ahrendsburg and Meiendorf, bones of the wild horse are reported from the late-glacial stages of the deposits. The plant indices are the high frequencies of *Artemisia* and *Hippophæ* pollen from late-glacial maxima of non-tree-pollen. Presence of *Hippophæ* is proved by finds of the peltate scales. Another index, a species of *Helianthemum,* now found in Central European mountains, but not in Scandinavian mountain regions, is frequent among late-glacial pollen samples. If on retreat of the ice from Denmark the tundra belt disappeared and forests extended practically to the ice margins, then suitable habitats for steppe elements would disappear and no subsequent immigration prove possible, since "the forest is inimical to both arctic and steppe elements". The mixed 'tundra' and 'steppe' flora and fauna probably existed in the belt of 'park tundra', rich in grasses and herbs, of up to a hundred kilometres wide as envisaged by Jessen. This zone and the associated fauna disappeared when post-glacial forest invasion commenced, only the bison and the wild horse lingering until the Maglemosean era in Denmark.

Prof. K. Faegri, of Bergen Museum, dealt with the position of *Hippophæ rhamnoides* in Norway, which in north Europe is restricted to the shores of the Baltic, the north Norwegian and south Danish coasts. Elsewhere in the 'regio alpina media' in Asia, and to sea-level in Scandinavia, it shows a fair degree of tolerance though with some preference for calcareous soil. The fossil distribution appears to have been wide in late-glacial times. A scarcity of localities from Norway is probably due to a scarcity of investigations. Knowledge of ecology suggests that its disappearance is unlikely to have been due to temperature changes. Competition, or the lack of it, or soil leaching are more likely factors, as is indicated by present distribution on regions of coastal uplift, that is, where new ground is continually present and where *Hippophæ* acts as a pioneer species and so maintains itself. The one or two inland stations recorded are similarly on friable calcareous cliffs where rockfalls keep the habitat open. It may be that until the post-glacial forests closed in there existed habitats of suitable open ground or with minimal competition in the shrub layer.

Dr. F. Mitchell, of Dublin, described discoveries in Ireland of remains of the giant Irish deer and reindeer. Recent work in Ireland on 'zoned' plant beds in relation to glacial deposits has led to a modification of Charlesworth's views of the distribution of the Newer Drift as shown in his map of 1929. This is the separation of the mountain glaciation phase in Ireland, principally of the Wicklow Mountains (and perhaps correspondingly, therefore, in the Welsh Mountains), as of a later date than the Newer Drift. The Scottish Re-advance may well date from this phase as well. In the lowlands solifluxion deposits were formed during the period of Jessen's Zone III. Two distribution maps were shown, one for late-glacial deposits, and localities with finds of giant Irish deer actually found embedded in such deposits, the other constructed for finds recorded in the literature, whether supported by reliable field evidence or not, of reindeer finds from open country sites (finds from limestone caves being neglected). There is a frequent association of reindeer bones with those of the giant deer, for example, at Ballybetagh.

In localities surrounded by steeper and better drained slopes the solifluxion layer may contain such arctic plants as *Armeria* (?*arctica*), *Dryas octopetala* and *Oxyria digyna.* The distribution of the two large mammals tends to be general except for a lack in the north and north-west. This compares with Jessen's recognition of tundra or open willow and juniper woods over most of Ireland, and *Empetrum* heaths in the north-west in the Allerød period; the former areas being grassier and thus possibly preferred by reindeer. The Allerød period appears to have been the period when the giant deer flourished; later finds of it are of dubious validity. One from the region to the north of the conjectural ice limit of the Scottish re-advance stage in Ulster, if confirmed, raises the problem of the contemporaneity of the Scottish and Wicklow mountain glaciations and the question of whether the fauna survived, however meagrely, into early post-glacial times. Probably extinction occurred, more or less completely, in the rigorous tundra phase after the Allerød period.

Dr. K. B. Blackburn, King's College, Newcastle, described two anomalous finds, one of *Trapa natans* in the Scottish Outer Isles, and one of the moose (*Alces Alces*) in the Tees Valley at Neasham. All they have in common is that both are now extinct in Britain, while both were present together in Cromer Forest Bed times.

The fossil *Trapa* nut was found entangled in floating *Potamogeton* debris in a loch in South Uist. The loch is brackish and connects to the sea-loch, Loch Eynort, by a tide-race 10 ft. wide and about 50–100 yd. long. The nut was dated by obtaining a pollen sample from adhering peat. 140 tree-pollen grains and some non-tree-pollens were obtained, and the spectrum constructed from them was matched with the longest peat profile diagram so far obtained in the neighbouring regions. The spectrum appeared to agree with a level about mid-Zone VII of the tentative zoning of the diagram. The two profiles, Stoneybridge and Calvay, both have an *Alnus* rise at the base which might be equated with the Zone VI–Zone VII transition to Atlantic times. The nut is assumed to be indigenous, since *Selaginella* and *Drosera* pollen occurred on the nut as in the Zone VII, and other zones of the diagrams, and, it may be added, in the local vegetation at present. No pollens were found on the nut that were not represented from the diagrams, and this also suggested that the nut had not been washed up Loch Eynort into Loch Ceann-a-bhaigh from the sea. A European distribution map for *Trapa* was shown.

The moose skeleton at Neasham fell out of a peaty band halfway up a brickpit face. This band is inferred to be a deep-water lake-mud. The sequence of deposits was as follows:

3. Clay.

2. { Upper peat.
Slightly laminated clay (locally known as 'prismatic' clay and generally considered to be a water-lain deposit).
Lower peat—Hypnum above, laminated below } (thinner towards side of section).

1. Clay.

In Raistrick's map of the distribution of late-glacial lakes ponded by the Cheviot Ice, one lake is shown over the Neasham district. A pollen diagram was made for the section. The lower peat shows high values for pine basally followed by high birch and willow and a reversion to high pine at the top. There is an increase in the alder curve in the upper peat which may mark the start of Zone VII. The central part, in which the moose was found, may be late-glacial; but the presence of high hazel values at the same level needs accounting for if the clay above is to be suggested as belonging to Zone III, and such correlations are scarcely justified at this stage. The present range of the moose includes the forested lake country of northern Canada.

Prof. Heslop Harrison's paper was read, in his absence, by Prof. Clapham. There are four elements concerned. The 'American' group of species such as *Spiranthes stricta*, *Eriocaulon*, *Sisyrynchium*, *Naias flexilis*, and the sponge *Heteromyelia Rylei*. This group is largely centred on the group of islands between the Outer and Inner Hebrides, Coll, Tiree, and Gunna, particularly the first-named. Secondly, the so-called 'Macaronesian' element including the moss *Myurium hebridarum*, which occurs in the Outer Isles in places, Coll, Tiree, and Eigg, in a non-fruiting state, its principal centre being the Canary Islands and the Azores. Another in this element is the water-beetle *Deronectes canariensis*. Thirdly, there is the development of the distinct Hebridean races of plants and animals common on the mainland, for example, wren, thrush and field-mouse and many insects; such plants as *Orchis hebridensis*, *Lonicera*, *Pericylmenum* var. *Clarkii*, *Rosa* spp. The fourth element is that of the arctic alpines.

All the problems have to be reviewed in relation to what is known, as yet, of the geological and geographical history of the whole group of islands during glacial and late-glacial times. There has been too much speculation about these regions up to the present, based on erroneous information or none.

Jehu and Craig considered some time ago the upper slopes, above 1,500 ft., of Bheinn Mohr in South Uist, to be unglaciated. The many changes of sea-level in glacial, late- and post-glacial times presume certain linkages and separations of the various island groups one with another, and with the mainland and Ireland. As regards such islands as Coll and Tiree, a not very extensive rise in former sea-level, for example, to the 100 ft. beach-level perhaps, would have been sufficient to submerge them completely, with consequent extinction of the flora and fauna. Similar extinction can be presumed for those islands that were completely glaciated at maximum or subsequent glaciations. Prof. Harrison openly admitted, however, that he has approached the problems with a bias towards a 100 per cent survival of flora and fauna. Pre-glacial raised beaches suggest the Hebrides to have been islands at the start of the Ice Age, presumably possessing a small flora representative of the rest of the mainland. To what extent this was overwhelmed, survived on nunataks, or migrated and afterwards immigrated, depends on glacial conditions at their maximum for each area. On Bheinn Mhor, South Uist, we find such plants as *Saxifraga stellaris*, *Sedum roseum*, *Oxryia digyna*, *Alopecurus alpinus* (this last nowhere else save on the mainland), *Silene acaulis*, *Carex capitata*, *C. bicolor*, *C. glacialis*, *Poa alpina*, *Arenaria gothica*, *Saussurea alpina*, and the mosses *Andrœa vittii*, *Ditrichum vaginans*, and *Myurium hebridarum*. Can we credit persistence of these plants here, and on mountains of similar heights in this and other islands, on ice-free ledges of high cliffs and nunataks, or possibly on land surfaces exposed by eustatic fall in sea-level? There is little glacial drift west of the exposed mountains on the Long Island, which may have been ice-free. Among faunal survivals are *Bombus* spp., *Salices*, the associated *Pontalia* and mites, and many spiders.

If the islands were cut off from the mainland after the last inter-glacial by an ice barrier, with no subsequent land connexion, we might account for the development of the Hebridean races. A previous connexion with the mainland during inter-glacial iso- and eu-static adjustments, allowing immigration to occur in the cases of those islands the floras and faunas of which had been overwhelmed at maximum glaciation previously, could be postulated. All this is hypothetical at the present state of our knowledge. *Campylopus Shoreii* and *Rubus* species may have immigrated with the Eu-Hebridean races and survived with them. Where the American element, absent from the Outer Isles, survived is a problem. Possibly on some ice-free area to the west of Ireland; the presence of *Eriocaulon* in inter-glacial deposits in the west of Ireland may be cited as indicative evidence. Presence before and after a glaciation without knowledge of other factors is not necessarily *a priori* evidence for survival, however, and the number of investigations of late- or inter-glacial deposits in the Western Isles is very small as yet.

The richness of the flora and fauna of the Inner Isles, in part, compared with that of the Outer Isles, was explained by assuming progressive west to east severance of land connexions. The Coll, Tiree group being cut off later, there was more time available for immigration.

Prof. Zeuner raised the question as to what evidence the geologist can supply towards reconstructing the ecological conditions during late-glacial times. The distribution of fossil soils shows a preponderance of solifluxion phenomena in the west, especially from the south of England and France, but east of the Rhine a dominance of loess types. With solifluxion on a frozen subsoil there may have been taiga conditions such as prevail to-day in Siberia. In the loess areas grass-steppe conditions with an absence of trees, except in the river valley bottoms, where the loess itself appears to be absent, may be conjectured. Between the loess and the Scandinavian ice there was a 10–100-km. wide belt, presumably of a tundra type, but differing from modern arctic types in its meteorological conditions. The radiation was possibly the same as that to-day for these latitudes, thus a richer flora and fauna may have been possible. The loess conditions disappeared after the Salpausselka stage, climate ameliorated, and the forest belt advanced northwards. Dr. Zeuner is opposed to the survivalists' theory of the Mediterranean and Lusitanian elements in Ireland and Scotland since the existence of the hypothetical land area between Ireland and Spain had never been proved, and he thought that to-day these forms just survived and could not have withstood the rigour of glacial conditions.

Mr. Wilmott assured the meeting that Lusitanian species do not merely just survive in Britain but also flourish from the mountains down to sea-level, although they may be ecotypes of species the southern forms of which could not survive. He cited an instance from a recent cold winter in which Irish forms of *Saxifraga umbrosa* in his garden survived but the Pyrenean forms were killed. He warned foreigners that in Britain they were dealing with the Atlantic climate, which could play many tricks. The Hebrides and Caithness are treeless, but this condition is governed by high winds and lack of snow cover in winter, not of temperature, and there is no tundra there. What degree of coldness did the presence of ice here really indicate ? He pointed out a similarity of British and Finnish floras even to-day.

Mr. C. Elton said that from a zoological point of view the Outer Isles, Shetlands, Isle of Man, etc., appear to have been separated from the rest of Britain since the last inter-glacial, since they lack so many, of the species common to the main island. Although the post-glacial vegetational history of Ireland seemed to imply a land connexion in the Holocene, this was inconceivable on zoological and geological grounds. Did man play a more important part than we have imagined up to the present ?

Prof. Jessen, replying to previous speakers, reaffirmed that Ireland in the late-glacial lay to the north of the forest limit. Whether 'tundra', or whatever else it might be called, it was treeless. *Arbutus* could scarcely have survived on a land surface between Ireland and Spain for, if it did exist, it must have been very oceanic and subject to high winds. *Arbutus* is a shelter-demanding species. Boreal species might have survived on nunatak areas in the south of England, but doubtfully Lusitanian species. The present distribution of *Trapa natans* is very sharply defined in the north-west of Europe to-day, in regions of Continental warm summers but immaterial winter conditions. He doubted if the 18° C. July isotherm ever existed in the Hebrides region in post-glacial times.

Dr. J. B. Simpson, who surveyed Coll and Tiree for the Geological Survey of Great Britain, was certain that they were completely glaciated at maximum glaciation. Glacial striæ occurred all over these islands at all heights. He wondered if human agency during the Viking period was responsible for any plant introductions. The Outer Isles were regular ports of call for galleys plying between Ireland and Iceland. Further, bird migrants, such as the shearwater, which goes south to the Canaries, might have influenced moss dispersal.

Prof. Faegri was somewhat against a Viking dispersal agency, as many of the species concerned, for example, *Arenaria norvegica*, *Carex bicolor*, were extremely rare even in Norway.

Dr. Farrington appealed to botanists to lay aside their speculations and instead seek to establish a reliable geological background for the phenomena of floral history. If the Welsh mountain ice proved to have been pushed about by Northern ice, then it must be earlier than the Wicklow Mountain glaciation. This was considered later than any major ice sheet in Ireland. If varying onsets were established for the different regions, the whole problem of the contemporaneity, at present assumed, was thrown into doubt. If the last glaciation was later than that in Denmark there was no discrepancy in the time for immigration of the floras to be explained. He stressed that the problem of contemporaneity of immigration assumes similar glacial and climatic developments in Ireland and in Denmark. There are good reasons for thinking that this is far from being the case and that local mountain glaciations occurred later in Ireland. During the Daniglacial and Gotiglacial stages it appears likely that there was a retreating ice margin in Scandinavia, but after the Salpausselka moraine stage the retreat was far more one of the decay of stagnant ice *in situ*. The Irish conditions are not yet clear. He asked, was the so-called Allerød oscillation contemporaneous or a stage in glacial retreat ?

Prof. Flörschutz (Holland) stated that *Trapa natans* was known from the primary and secondary inter-glacials and from Atlantic times, as a fossil, in Holland.

Dr. E. S. Brown contributed information on insect faunas in the Faroe Islands. In a certain species of Tipulid (cranefly), *T. pagana*, the females were wingless and therefore could not migrate by flight. Assuming the Faroes to have been islands since late-glacial times, how had this species colonized them ? Bird migration was an unlikely factor since the Tipulid eggs were produced in autumn when the birds were migrating southwards. Human dispersal by boat was also considered unlikely. On many different islands in the group, up to forty miles apart, another species occurred the females of which were practically wingless and in the same position, as regards migration, as *T. pagana*. Transport in hay was later suggested as a factor.

Dr. P. W. Richards suggested that Bryophytes may well prove valuable in the study of these problems. The British flora is particularly rich in relict species, for example, the liverworts, *Mastigophora Woodsii* and *Scapania nimbosa*, restricted to the Hebrides, Western Ireland and Western Scotland, and the moss, *Myurium hebridarum*, are probably pre-glacial relicts. None of these shows spore reproduction in its present station, except *Myurium* in the Canary Islands, and none has any means of vegetative reproduction. He considered bird dispersal of Bryophytes to be very improbable. Attention was directed to a British–Chinese element represented by *Mastigophora* with a disjunct distribution in Eastern Asia and the Hebrides. This is comparable to the Chinese–American flora, with only fossil representatives in Europe, for example, *Magnolia*. He suggested that Bryophyte representatives of these floras, with their small size and great tolerance of unfavourable conditions, might well have survived as relict species to-day. Prof. Jessen's conclusions on the oceanic nature of the late-glacial climate in Ireland were noteworthy. Such species of the arctic–alpine group, for example, *Paludella squarrosa*, with a relict southern distribution but fairly frequent in the north until drainage operations have caused it lately to diminish, has a very poor representation in Ireland. Could this be due to there never having been suitable conditions there for its establishment after glacial times ?

Dr. W. A. Clarke pointed out that the flora of Rhum stands somewhat apart from that of neighbouring islands, possibly due to the higher mountains, reproducing the non-glaciated upper slope conditions of Bhienn Mhor group, South Uist. Such plants as *Poa alpina*, *Saussurea alpina*, *Thlaspi alpestre*, and *Arenaria norvegica* are present in some quantity at only 1,500 ft. The nature of the summits and ridges with angular non-glaciated, but excessively frost-shattered, debris recalls Fernald's mountain top survival sites in Newfoundland. The moss *Myurium* is frequent up to the summit of Bheinn Mhor, South Uist, though the several expeditions to the Clisham area in Harris have not found it there also. He suggested that its lowlands stations were colonized afresh, after survival in the mountain regions, namely, *Myurium* on Ben na Hoe sea cliff, South Uist, mentioned by Prof. Harrison.

SCIENCE IN ADULT EDUCATION

By Dr. M. H. CLIFFORD

Board of Extra-Mural Studies, University of Cambridge

DURING 1946, full-time appointments of tutors to give extra-mural instruction in the natural sciences were made both by the University of Birmingham and by the University of Cambridge. The inclusion of natural scientists in the staffs of extra-mural departments is a development which reflects the increasing recognition of the importance of, and the growing demand for, the teaching of science to adults.

The Education Act of 1944 has charged local authorities with the duty of securing for their areas the provision of adequate facilities for further education. But in this undertaking they are required to consult with the university extra-mural departments and with the voluntary bodies, such as the Workers' Educational Association, which have built up traditions and developed practice in this field over very many years. The cost of lecture courses provided by these bodies is met in part by direct grants from the Ministry of Education amounting to not less than three-quarters of the lecturers' fees, subject to the classes conforming to regulations determined by the Minister. For the year 1944–45 approximately £105,000 was thus disbursed by the Ministry. Tuition is given in courses which vary in duration and in the level of instruction. Terminal and university extension courses usually extend to twelve lectures, while sessional classes normally include twenty-four lectures. Tutorial classes extend over three successive winter sessions, each session comprising twenty-four weekly meetings. In this provision for further education the representation of scientific subjects has been, and still is, very slight. During 1944–45 natural science courses in England, Wales and Scotland arranged by the Workers' Educational Association, either on its own or in co-operation with universities, amounted to not more than 4·5 per cent of the total number of courses in all subjects. This figure excludes courses in psychology (6·9 per cent of total) and in anthropology (0·2 per cent). These are customarily classed with the social sciences. In a large number of cases the approach to psychology is philosophical rather than experimental. The accompanying table records the provision of science courses during the last four sessions by the Board of Extra-Mural Studies of the University of Cambridge, having regard to the two sides of its work. Extension lectures are provided through local centres committees: tutorial and sessional classes are normally provided by joint action with the Workers' Educational Association.

Board of Extra-Mural Studies, University of Cambridge. Frequency of courses in natural sciences, 1942–46

Session	University extension courses			Tutorial and sessional classes		
	Total courses in all subjects	Courses in science*		Total courses in all subjects	Courses in science*	
		Number	Per cent of total		Number	Per cent of total
1942–43	74	1	1·4	28	3	10·7
1943–44	81	2	2·5	30	1	3·3
1944–45	93	1	1·1	63	5	7·9
1945–46	69	1	1·5	73	12	16·4

* Chiefly biology or the social relations of science.

In the latter connexion it will be observed that there has, during the last four years, been a marked expansion in the number, and, to a less extent, in the proportion, of courses in science. This growth can in part be correlated with the availability of certain tutors, chiefly biologists, and with a planned endeavour to discover reasons for the apparent lack of interest in science among adult students, an occurrence which did not correspond well with the known demand for popular books on scientific subjects. Certain aspects of that problem are discussed below.

To some extent, unfamiliarity with science on the part of organisers and administrators in adult education has put science courses at a disadvantage when, in company with more familiar alternatives such as literature, history and social studies, they have been set before potential student groups for choice to be made of a subject of study for the ensuing year. Secondly, there has been an insufficiency of scientific workers offering themselves as tutors, partly on account of indifference to the claims of such work, but also on account of an unawareness of its existence or an insufficiency of time to devote to its furtherance. Lastly, it would appear that not enough attention has always been given to the special needs, and the special limitations, of adult students by those who have been concerned with the teaching of science in extra-mural classes.

To-day it is likely that these last two groups of factors—namely, lack of scientific workers willing to teach in adult education, and lack of attention to the problems of teaching science in adult education—are the most important ones hindering the desired convergence of men of science and laymen in an educational partnership. Students and administrators, alike, are coming more and more to recognize the desirability of such a development, but great difficulty is being found in the provision of suitable tutors. At the present time the teaching of science within the area served by the Cambridge Board of Extra-Mural Studies could be at once expanded if more tutors were available, science courses having had to be refused on account of the scarcity of tutors. Men of science who are anxious that their work should not become divorced from the interest and understanding of the ordinary citizen have a responsibility to give this matter their urgent consideration. For the man or woman who has the necessary abilities this work, while often arduous, is most rewarding, not least on account of the extent to which tutors can learn from their students, both in matters of fact and in matters of outlook. Tutors' expenses are found and a fee is paid according to the type of class and the degree of experience of the tutor. Work is normally on a part-time basis, and no more than one class per week need be undertaken. Thus despite the pressure of professional work it should be possible for many more scientific workers to participate in this work than are doing so at present. Persons qualified in some branch of science who would wish to share in the task of bringing the scientific point of view to their fellow citizens should get into touch either with the extra-mural department of the nearest university, or with the central office of the Workers' Educational Association, 38*a* St. George's Drive, London, S.W.1.

The writer of this article has recently published (*Discovery*, Sept.–Oct., 1946) a fuller account of techniques found useful in the teaching of science to adults, a review of the problem which it is hoped will be of assistance to persons about to undertake work of this kind. Further, there is now an increasing tendency for extra-mural departments of universities to offer some opportunity of training to potential tutors in adult education. For example, in 1947 the Cambridge Board of Extra-Mural Studies will arrange, for the second year in succession, a fortnight's course for this purpose. It will be intended for persons with suitable academic qualifications who need advice about conducting adult classes and teaching their subjects therein. Advice about teaching methods will be given by experienced tutors, and there will be opportunities for meeting and giving practice talks to adult students. Background information concerning adult education and its development will also be given. Such courses do not claim to offer anything in the nature of a complete training, but they provide a valuable opportunity for would-be tutors to acquire some knowledge and personal experience preparatory to embarking upon an adult class.

In a short article it is only possible to consider very generally the part that science has to play in the education of adults, and the form in which it may most readily gain their attention. This is dealt with at greater length in *Adult Education*.

Experience in the area of the Cambridge Board of Extra-Mural Studies has clearly shown that, at the present time, for the majority of adults interested in adult education it is the approach by way of the social significance of science that is most successful in arousing interest, and in evoking the effort necessary for regular and effective attendance during a course of twelve or more lectures. While the social approach to science is far from being the only important one for the ordinary citizen, it is manifestly the approach of the moment. Scientific workers are accustomed to being opportunists in their own fields, doing what they can, when they can, and how they can. They would do well to employ similar tactics in bringing their subject to the notice of others.

In the hands of a skilful tutor the exposition of science in its social setting can lead to a more informed appreciation of the problems of citizenship, and to a more widespread understanding of the scientific method. Recognition of the fact that science is an activity distinguishable by its methods, rather than the simple pursuit of gadgets and cures, is still very rare among laymen. This situation is largely responsible for the continuance of the belief, still held by many, that science has no place in the liberal education of adults since it has no cultural contribution to make.

The social approach to science makes especial demands upon the tutor, who will need to be widely read outside his own subject, and able to recognize frankly his own vested interest in the scientific outlook. Tendentiousness will bring discredit upon those who practise it as tutors in an educational activity where emphasis is placed upon the need for objective inquiry on the part of students who are motivated by considerations of a practical and social character. To-day the frontiers between natural science on one hand, and psychology, economics, and philosophy on the other, are often vague and difficult of definition. This makes still greater the necessity for objectivity on the part of the tutor. Some men of science will consider it inappropriate to discuss these disputed fields in advance of a more complete study of them by the methods of science. But students will persist in bringing forward wide-ranging issues in which science is involved, such as, for example, the place of scientific method in the investigation of public opinion; the part to be played by science in the formation of opinion, both in propaganda and in education; the attitude of scientific workers to the concepts of creation, free will, democracy, and to the question of the mind–body relationship. Therefore, it would seem advisable that the tutor should be able to deal with such topics in the light of previous contemplation rather than impromptu. Scientific speculation, when self-confessed, can play an important part both in the establishment of new branches of science and in the general advancement of social awareness. It is a characteristic of adult education to be rich in demands for the study of subjects which, at present, do not fall conveniently into the conventional divisions of knowledge made by the universities for their own purposes. This is a fact the implications of which have not yet been very much explored by educationists.

Hitherto the demand for science courses of a more academic character has arisen only from a minority of adults. It is hoped that this demand will develop, both as a result of direct encouragement, and as a result of the more widespread introduction of students to science by way of the social approach. It must, however, be remembered that the intention of adult education is not to produce professional research workers; though there are a few scholarships enabling exceptionally qualified students to proceed from adult classes to full-time university courses. The hope is, rather, to increase understanding and to widen outlook. Consequently, the teaching methods employed will not necessarily coincide with those suitable for the vocational training of scientific workers. Experience suggests that it is usually better to build up the more academic type of treatment in relation to topics in which there is already some considerable amount of amateur activity. These may be matters of local interest, including natural history; or subjects with vocational aspects, such as gardening, home nursing, motor-car maintenance, or radio. Courses in biology have been very successful when based upon the interests of local field clubs. It is recognized that courses of this type must be as fully experimental as possible—a provision which in adult education still presents many difficulties from the point of view of organisation.

With respect to both of the routes by which science may be approached, whether social or academic, it is biologists who have made the greatest progress in the business of relating their material to the needs of the ordinary man. It has been said that this has largely resulted from the advantages which biology enjoys with respect to its subject-matter and its methods. With respect to methods, genetics is a department of biology that is to a great extent dependent upon mathematical techniques, and which, like physics and chemistry, is advanced by the use of symbols. Nevertheless, the popularizers of biology have to a considerable extent found it possible to include the subject-matter of genetics within their purview. So far as interest value is concerned, physicists and chemists have acquired a powerful pull on the public mind with the opening of the age of atomic energy. The success of certain carefully designed books expounding the physical sciences for the ordinary man leaves one with the impression that in lecture courses much could be done with similar subject-matter. Indeed, the experience, not only of an earlier generation but also of more recent years, is that public interest is keen if lecture courses on such topics are given by lecturers who have the necessary gift of lucid exposition and an ability to relate their subject-matter to the familiar experiences of everyday life. If more physical scientific workers of the present generation would devote time to discovering, by trial and error, techniques suited to the popular exposition of their subjects through the spoken word, these sciences might within a few years come to be as much in demand as the biological sciences.

But experience in adult education suggests that it is not necessary, nor even desirable, for lecturers in science to confine themselves too narrowly within their own research subjects, any more than occurs with school teachers or schools' examiners. Scientific workers when participating in adult education are not authorities addressing their professional equals, but expositors serving the needs of laymen. Their position closely resembles that of the political commentator attempting to assist public understanding of current affairs. Indeed, they may even prove to be more effective as tutors if they can share some of the difficulties experienced by their students when surveying the territory of science. To-day, scientific workers are presented with great opportunities in the field of adult education. Are they willing and ready to take advantage of them ?

THE INTERNATIONAL UNION OF PHYSICS

ACTIVITIES OF THE UNION, 1923-39

AT the close of the First World War, the main pre-war international scientific organisations, some of which had been dominated by Germany, had collapsed. It was therefore decided to create a series of scientific unions to promote international co-operation. The Union of Pure and Applied Physics was formed at the end of 1923. In 1934 the Union held its most important assembly of the inter-war period. At this assembly, which was held in London, it received a report from the Commission on Standards, Units and Nomenclature which it had previously established. It approved recommendations concerning (*a*) thermal units, (*b*) units and nomenclature of electromagnetism (including the adoption of the 'oersted'), and (*c*) the nomenclature of thermodynamics. It decided that the Commission should continue its work, and should (i) co-operate with other international bodies in relation to definitions of terms, (ii) prepare lists and definitions of terms occurring in two or more branches of physics, and (iii) assist those who, in any country, are preparing such lists. The Commission was not intended to conduct technical investigations, such as those guided by the International Commission on Illumination. It was to receive and to review data prepared by technical commissions and to decide whether to recommend their general adoption by physicists. Associated with the 1934 Assembly was a public conference, including sections on (*a*) nuclear physics, and (*b*) the solid state. This very successful conference was held jointly with the Physical Society of London, which was mainly responsible for the organisation.

The work of the International Union of Physics may fairly be compared with that of some of the other unions which are also members of the International Council of Scientific Unions. The International Astronomical Union united thirty-four standing committees and organised many important research projects. The Union of Geodesy and Geophysics was also very active. On the other hand, the projected Union of Biological Sciences never achieved biological existence ! The International Union of Pure and Applied Physics was useful—but in a limited way. One reason for its rather slight activity was that its constituent members, the national committees, were not very active in any country, and were non-existent in many.

The Assembly in Paris, January 1947

Against this background we may now consider the recent assembly held at the Sorbonne with Prof. M. Siegbahn (Sweden) as president. The secretary was Prof. P. P. Ewald (Belfast). He had undertaken the office, at the request of the president, after the death of Prof. Abraham, who had been secretary since 1923. The local arrangements were made by Prof. Fleury (director of the Institut d'Optique). The conference recognized that it owed more than a formal vote of thanks to Prof. Ewald and Prof. Fleury, whose hard work in very difficult circumstances enabled it to function smoothly. The following countries were represented: Australia, Belgium, China, Czechoslovakia, Denmark, France, Finland, Great Britain, Italy, Netherlands, Norway, Poland, Spain, Sweden, Switzerland.

From this list it may be seen that Western Europe is well represented, and there were also some scientific workers from Eastern Europe, although the U.S.S.R. did not accept the invitation to attend. It is hoped that the causes which prevented the representation of the United States, Canada and India are purely temporary, and that they will send delegates to the next assembly. It was suggested that ex-enemy States may also be invited as soon as peace treaties have been signed.

Apart from the necessary business of electing new officers, etc., which will be dealt with later, the chief discussion centred on the future policy of the Union. There were two chief schools of thought. The first view (sponsored by the Dutch delegation) was that the assembly should give a strong lead by appointing a large number of commissions to organise international co-operation in various branches of physics. It was urged that if this were not done, various organisations independent of the International Union of Physics would come into existence. Already a Union of Applied Mechanics and a Union of Crystallography have been formed. The Réunion des Opticiens held in Paris in October appointed a continuation committee to organise international co-operation in optics. This committee is at present willing to work as part of the International Union of Physics if possible. The Dutch delegates urged the formation of Commissions for Optics, Nuclear Physics, Low Temperatures, Magnetism, Metals, Spectrum Analysis, Cosmic Rays, Crystallography and Mechanics. On the other hand, some delegates felt that an attempt to 'organise physics from above' would certainly fail. Co-operation must be a matter of organic growth. It was believed that all the International Union can do is to recognize an urge for co-operation among a group of workers when it occurs spontaneously (as had happened with optics) and give the support of the Union.

Clearly, either of these arguments pushed to extremes must lead to absurdity. Too ambitious a programme at present would lead to a cumbersome international 'organisation' with nothing to organise. On the other hand, if the Union always waited for sections to make their plans complete, those in favour of co-operation would form separate unions, and the Union of Physics would lose its *raison d'être*. The British delegates suggested that physical sciences can, for purposes of international co-operation, be divided into two groups. The first group includes subjects such as cosmic rays and physics of the atmosphere, in which observations made at different parts of the earth's surface are complementary. An international organisation of those branches of physics may expect to undertake important projects of research which no one country could organise. The second group includes subjects such as optics and acoustics, which are concerned with the measurement of quantities which do not vary with latitude and longitude. International projects of research are likely to be less important in these subjects—though they are not impossible. Both groups of sciences may expect to benefit from international discussion of units and nomenclature and from personal contacts. On this view the International Union should establish commissions where important research projects are possible, and also where there is evidence that workers in a certain branch of physics would welcome the formation of a commission. It was decided to establish the following commissions :

(1) *Cosmic Rays :* to study the possibility of international co-operation in observations. *Chairman :* J. Clay ; *Secretary :* P. Auger ; *Members :* P. M. S. Blackett, W. Heitler, B. Gross, B. Rossi.

(2) *Units of Radioactivity :* to consider the proposals of Condon and Curtiss (see *Rev. Sci. Instr.*, June 1946). *Chairman :* E. U. Condon ; *Members :* L. F. Curtiss, Sir Charles Darwin, E. Evans, J. C. Jacobsen, Mme. Joliot, M. Siegbahn, C. G. J. Sizoo.

(3) *Symbols, Units and Nomenclature :* to continue the work of the former commission. *Members :* P. Fleury, Ezer Griffiths, A. Pérard, Van Dijk.

(4) *Thermodynamics :* to study the definitions and nomenclature of thermodynamics and thermochemistry and to co-operate with the Commission on Standards, Units and Nomenclature, and with the International Union of Chemistry. *Members :* E. Bauer, De Boer and E. A. Guggenheim.

(5) *Optics :* to form a preparatory commission to consult the Optical Groups of various countries on the best way to bring the organisation proposed at the Réunion des Opticiens (held in October) within the framework of the International Union of Physics. The members of the preparatory commission are to co-opt persons chosen by the Optical Groups in each country so as to form a fully representative commission, the full commission to meet at an early date (probably in June at Prague). *Secretary :* P. Fleury ; *Members :* R. W. Ditchburn, J. Hrdlička, E. Perucca and A. C. S. Van Heel.

The conference also appointed representatives on joint commissions dealing with (*a*) physico-chemical data, (*b*) viscosity, (*c*) the ionosphere, (*d*) radio-meteorology.

The Assembly elected Prof. Kramers as president, Prof. Fleury as secretary and Prof. Pérard as treasurer. A number of vice-presidents, including Sir Charles Darwin, were also elected. The officers form an executive committee to act until the next assembly. The executive has power to form further commissions if there is evidence that this is desired. Any suggestion for the formation of a new commission or for any other project of international co-operation may be made to the executive through a national committee for physics.

Relations with the United Nations Educational, Scientific and Cultural Organisation

The Assembly received a report of an agreement between the United Nations Educational, Scientific and Cultural Organisation and the International Council of Scientific Unions. Under this agreement the Organisation recognizes the International Scientific Unions as "providing a natural form for the international organisation of science". It agrees to help them financially in regard to (*a*) international research projects, (*b*) travel expenditure, and (*c*) provision of office space, secretarial service in arrangement of meetings, etc., but *not* the general secretarial expenses of the Unions. It is expected that in conjunction with the Organisation the International Union of Physics may undertake the compilation of panels of experts in every branch of physics and, later, the publication of an international directory of physics. This directory is to include lists of laboratories with the names of workers and types of research. Other projects discussed include the publication of 'handbooks' of a type too expensive for one nation and the establishment of archives (that is, records, such as manuscripts, films, etc., of experiments and of persons of historical importance).

It was recognized that the details of co-operation with the United Nations Educational, Scientific and Cultural Organisation must be worked out gradually over a period of years; but it was felt that the agreement with the Organisation alters the whole outlook of the International Unions. They should now have sufficient funds for all useful work which lies within their terms of reference, and the backing of a permanent secretariat and a permanent organisation.

The Assembly decided to meet again in September 1948 in Holland. The interval is shorter than the usual interval of three years between meetings of the assembly, but a fairly early meeting is desirable to review the working of the new commissions and to make any alterations in statutes which may be needed to secure the full benefit of co-operation with the United Nations Educational, Scientific and Cultural Organisation.

Conclusion

May I conclude this article on a note of optimism —*restrained* optimism, but still optimism—concerning the future of the Union. The Paris Assembly was a friendly conference and its programme, although not excessively ambitious, is practical. Each of the commissions exists to meet a demand—and has therefore a definite and natural field of reference. It may be that more commissions ought to have been set up, but if the demand for this or any other useful action arises before 1948, the executive can act. Finally, the agreement with the United Nations Educational, Scientific and Cultural Organisation offers the prospect of achieving stable and permanent co-operation in science. The extent of this co-operation may be expected to grow. The rate of growth will depend on the support received from national and local scientific societies and from individual scientific workers.

R. W. DITCHBURN

OBITUARIES

Dr. Alexander Scott, F.R.S.

At the great age of ninety-three, Dr. Alexander Scott died at Ringwood, Hampshire, on March 10. He was educated at Selkirk Grammar School, of which his father was rector, and at the University of Edinburgh, where he took first place in chemistry. In 1875 he became assistant to the Jacksonian professor at Cambridge, and having been awarded a Clothworkers' Exhibition in 1876 and a foundation scholarship of Trinity College in 1878, he gained a first class in the Natural Sciences Tripos in 1879.

From 1884 Scott spent seven years organising the teaching of science in Durham School and Middlesbrough High School. It was while here that Scott found the teaching of science in poor case, being handicapped by science masters either ill-trained or having to subordinate their efforts to preparing their pupils for answering the highly specialized questions of scholarship examinations. In his presidential address to the Chemical Society in 1916, the opportunity for successful careers for science students is compared with the rewards open to classical or mathematical students, and an appeal is made for a change in outlook. Whatever our views may be as to the early concentration on purely scientific subjects, it must be allowed that some progress has now been made in the betterment of the position of the scientific man.

Returning to Cambridge in 1891, Scott resumed work under Dewar, the Jacksonian professor, but five years later removed to London, where he became superintendent of the Davy Faraday Research Laboratory of the Royal Institution (1896–1911), Dewar being director. This Laboratory had been provided by Dr. Ludwig Mond in 1896 to afford opportunities for skilled men with the wish and time to devote to the solution of important problems.

Here Scott for fifteen years devoted himself to chemical work, which he pushed to the highest degree of accuracy, in his determination of atomic weights and of fundamental ratios such as that between hydrogen and oxygen.

Impressed by the accuracy of the work of Stas and by the view of that chemist of the illusory character of Prout's hypothesis—that the atomic weights of the elements are multiples of that of hydrogen—he remarks in his second presidential address to the Chemical Society that under its spell everyone falls who engages in work on atomic weights. This spell had certainly its influence on Scott, who by his skill and critical faculty clearly showed that Prout's hypothesis, in its original acceptation, could not be maintained; but he held that no work undertaken to determine the atomic weight of any element has led directly or indirectly to such an "increase in natural knowledge" as that centring around nitrogen, on which he did much careful work. Before the subject was cleared up by the discovery of isotopes, Scott in 1917 looked forward "to future investigation to focus out what is the true expression underlying Prout's principle", so that it would "lose its character as a will-of-the-wisp which it had borne in the eyes of so many distinguished men for a hundred years".

In his position as superintendent of the Davy Faraday Research Laboratory, Scott's relations with the workers there were amicable and helpful; many of them are now well known for the researches which they completed during their stay or as a result of further labours after leaving. Among them were Horace T. Brown, H. Debus, A. Liversidge, A. Mallock, Hugo Müller, Joseph Petavel, Charles E. S. Phillips, P. C. Ray, W. J. Russell, G. Senter and H. T. Tizard. Intolerant of slipshod work, Scott held the respect of his staff and showed a kindly friendliness to the sincere worker, a phrase used recently by one of the workers of that time now with us.

Scott was secretary to the Chemical Society (1899–1904) and treasurer (1904–15), much to the benefit of that Society; during 1915–17 he was its president. He was elected into the Royal Society in 1898, and elected a member of the Athenæum under Rule II in 1923. In 1906 he married Agnes Mary, daughter of Dr. W. J. Russell, F.R.S., and leaves no family. Robert Robertson

I first met Dr. Scott when he was seventy-one years of age: erect, with an imposing presence and an immense fund of scientific knowledge; critical, but, as I was to discover, with a capacity for kindness and friendship which can seldom have been surpassed. In 1919 he was invited by the Department of Scientific and Industrial Research at the instance of the Trustees of the British Museum to prepare a report on the condition of museum objects subsequent to their storage in a war-time repository. In accordance with his recommendation, a research laboratory was established at the British Museum, and he was director there until his retirement in 1931. I had the honour to be his assistant. During this period he made various important contributions to restoration work in the fields of archæology and painting, and such studies were his absorbing interest until the last.

Scott was particularly fitted to make these investigations. His career of service to chemistry had by no means precluded ancillary studies: he was a keen botanist and was prepared to tackle almost any inquiry in his private laboratory at home, from the most exacting work on atomic weights to the microscopical identification of plant structures. He was interested in solving problems for their own sake and could not resist the urge to experimentation. Thus it was that his advice was sought by all and sundry, and it was given generously and gratuitously.

He visited Luxor in 1923 and co-operated with Dr. Howard Carter and his chemical advisor, Alfred Lucas, in the prodigious task of organising the preservation of the objects from the tomb of Tut-ankh-Amun discovered the previous year—a task which was, as all the world knows, accomplished in the most trying circumstances with outstanding success.

It can have fallen to few to live the full life of service to science described above by Sir Robert Robertson, and to go beyond this and find time and energy in his latter years to become an authority of international repute in an entirely new field. If for nothing else, the name of Alexander Scott will be remembered for his pioneer work in inculcating the laboratory idea in museums: the recent development of this section of museology both in Great Britain and abroad bears testimony to his vision and judgment.

In the quality of his accomplishments Scott was a great man. He was, in addition, a notable benefactor to scientific research and, in my own knowledge, he helped many to a settled and happy life. He lived for science and truth, and found in this creed the formula of happiness. H. J. Plenderleith

Sir Joseph Barcroft, C.B.E., F.R.S.

On March 21 Sir Joseph Barcroft died suddenly at Cambridge from a heart attack. He had been hurrying to catch the bus which took him home from the Physiological Laboratory; he was seventy-four, and arthritis had begun to make cycling difficult, but this was the only sign that he was no longer as vigorous as ever. His occasional lectures were no less stimulating, he was an inspiring chairman of the newly formed Nutrition Society, an active member of countless committees, and after fifty years of research he could still open up unexplored fields and arouse the enthusiasm of the students who crowded his laboratory. He had just finished his yearly researches on the embryo sheep and had seen the publication of his new volume on fœtal physiology, "Researches on Pre-Natal Life" (see review by Dr. F. H. A. Marshall in *Nature* of March 22). He would have faced retirement philosophically; but his friends may be glad that he had no need to become inactive.

Barcroft was born on July 26, 1872, son of the late Henry Barcroft, of Newry, Co. Down. His family were Quakers, settled in Ireland since the seventeenth century, and their way of life must have been partly responsible for his calm but unrelenting pursuit of knowledge. He went to Bootham School, York, and then to the Leys School, Cambridge, entering King's College, Cambridge, in 1894. After a first class in both parts of the Natural Sciences Tripos he became demonstrator in physiology to Prof. Langley. In 1915 and again in 1939 he left academic physiology to work on the problems of gas warfare, but the rest of his life was spent in Cambridge, as professor of physiology from 1925 until 1937, and as director of the Agricultural Research Council Research Unit in Animal Physiology from 1941 onwards.

His work in physiology was always that of a pioneer; he had a genius for finding uncharted territory even in the most familiar regions, and for solving well-worn problems by an approach at a new angle. There are three major fields in which his work is classical: the physical chemistry of oxyhæmoglobin, the distribution of the blood between the storage depots and the circulation, and the physiology of fœtal life. In all three he set the fashion in current physiological research, but though many workers came to him for inspiration at each stage in his scientific career, he refused to become the specialist, and moved on as soon as he was satisfied that the main outlines were settled. He settled them by simple methods and simple ideas, leaving the complexities to be cleared up by those who understood them, but very rarely misjudging the main issues. He had, in fact, a wide range of scientific knowledge at his disposal and was at home with physical and chemical as well as biological ideas; but he knew the plain speech of the Quakers and wrote and spoke as a plain man with no claim to superior learning. He used to quote with delight the tribute of a foreign physiologist who said: "I like your book, Barcroft. It is so clearly wrotten!"

Besides their clarity, Barcroft's books are written with an engaging friendliness. They speak of yachting, travel and companions as accessories to physiological research, and no one who reads them will wonder at the constant stream of young men who came to him for training and encouragement. He was never at a loss for problems suited to the beginner or to the senior colleague; he knew where to go for help when some new technique was needed, whether its home was in Cambridge or abroad, and he could always attract a small army of collaborators when one of his major investigations was afoot.

Many honours came to Barcroft, including the Copley Medal of the Royal Society. Though he worked very hard, he was never too busy to help those who came to him for advice, and many did so. He could be relied on to introduce a speaker or propose a toast with a charming blend of humour and good sense, and in a private gathering he was the best of company. His sturdy figure will be greatly missed at the forthcoming International Congress of Physiology, for he had become one of the elder statesmen of the science, although he was never out of touch with the rank and file. There must be laboratories in all parts of the world where Barcroft will be remembered with esteem and affection for his personal qualities even more than for his great achievement as a physiologist. E. D. Adrian

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We regret to announce the following deaths:

Mr. W. J. Bean, C.V.O., formerly curator of the Royal Botanic Gardens, Kew, on April 19, aged eighty-three.

Dr. J. D. Falconer, formerly director of the Geological Survey of Nigeria, on April 16, aged seventy.

NEWS and VIEWS

Reports on Penicillin

The Medical Research Council, acting on the advice of its Committee for Penicillin Synthesis, is making available for consultation by interested persons a number of reports on penicillin. In October 1943, when many of the structural features of the penicillin molecule were becoming clear through the work carried out in Great Britain, the problem of the synthesis became a pressing one, and to handle this aspect, the Medical Research Council set up a Committee for Penicillin Synthesis "to initiate, co-ordinate and make investigations on the synthesis of penicillin and analogues". At the same time the Committee for Medical Research of the Office of Scientific Research and Development in Washington, which had already undertaken the co-ordination of chemical work on penicillin in the United States, came to an agreement with the Medical Research Council for an exchange of information on anything which had a bearing on the problem of the synthesis of penicillin. The confidential reports which were issued and exchanged are known in Great Britain as the C.P.S. reports. A number of reports known as the Pen. reports and sponsored by the Therapeutic Research Corporation of Great Britain contain much information of historical value on the earlier work carried out on the structure of penicillin.

All these reports, together with others sponsored by Imperial Chemical (Pharmaceuticals) Ltd., Merck and Co. Inc., and the Squibb Institute for Medical Research, are now available for consultation in certain libraries in Great Britain. In the London area the reports may be consulted in the libraries of the Royal Society; National Institute for Medical Research; British Drug Houses, Ltd.; Glaxo Laboratories, Ltd.; Wellcome Chemical Research Laboratories, Beckenham; May and Baker, Ltd., Dagenham; and in the provinces in the libraries of the Universities of Birmingham, Bristol, Cambridge, Glasgow, Manchester and Oxford. In the Nottingham area the reports may be consulted in the library of Boots Pure Drug Co., Ltd. The information contained in these reports cannot be made the subject of any publication before the Penicillin Monograph appears later in the year.

Biochemistry at Guy's Hospital Medical School: Prof. R. H. S. Thompson

THE appointment of Dr. R. H. S. Thompson to the new University chair of chemical pathology at Guy's Hospital Medical School, London, is no surprise to those acquainted with his work. During the course of a distinguished career, he has been concerned in some twenty-nine publications covering several aspects of biochemistry. As a Millard scholar of Trinity College, Oxford, he early showed promise and became senior demy of Magdalen College in 1933. At this time he worked with Prof. R. A. Peters upon the role of vitamin B_1 in the metabolism of pyruvic acid in brain; extending the work (with R. E. Johnson) to the important observation, now applied clinically, of increased pyruvic acid in blood in the terminal conditions of this deficiency. Following this, as a scholar at Guy's Hospital, he was awarded the Laidlaw Prize in 1937 and published research with Prof. G. Payling Wright on the chemistry of Gaucher's disease. As the Adrian Stokes travelling fellow, working with Dr. Dubos at the Rockefeller Institute in New York (1937–38), he published work upon the important enzyme ribonuclease, and upon the production of experimental osteomyelitis. Upon his return to Oxford in 1938, he became University demonstrator in biochemistry and fellow and tutor of University College. Since 1946, he has acted as dean of the Medical School. At the outbreak of the War he joined the team working upon antidotes to the war gases under the direction of Prof. Peters and took a prominent part with Dr. L. A. Stocken in the discovery and development of British anti-lewisite (2-3 dimercaptopropenol). He has also been much concerned with the clinical developments of this substance and is now acting as secretary of the Medical Research Council Conference on *B.A.L.* During the War he also co-operated with Netley Hospital in the nutritional treatment of post-arsphenamine jaundice, and in 1944–46 was attached to the Australian Army as Major, R.A.M.C. He was awarded in 1943 the Radcliffe Prize for medical research, Oxford.

University College, Nottingham: School of Agriculture

THE Midland Agricultural College at Sutton Bonington has become the University College of Nottingham School of Agriculture. The Midland Agricultural College has had a long and distinguished association with agricultural and dairying education. The agricultural section started as the agricultural department of University College, Nottingham, in 1892. In 1895 the Midland Dairy Institute was established at Kingston-on-Soar, and in 1900 the agricultural department was moved out into the country to link up with the dairy side. The subsequent development of the Midland Agricultural College was due very largely to the four local county councils of Derbyshire, Leicestershire, Lindsey and Nottinghamshire. In 1942 the governing body made recommendations to the associated county councils that the immediate needs of agricultural education could be served by the development of farm institutes in the counties and that the College should be reserved for higher agricultural education and research; in 1943 the University College of Nottingham instituted a Faculty of Agriculture and Horticulture, and the principal of the Midland Agricultural College was appointed to the staff of the University College as the professor of agriculture. University College, Nottingham, has bought out the county council interests in the Midland College, and the money will be used by the councils in the development of county farm institutes.

The entire staff of the Midland Agricultural College is being transferred to the staff of the University College of Nottingham. Prof. H. G. Robinson, who has been at Sutton Bonington for twenty-two years and for the last twelve years as principal, becomes the first director of the new School of Agriculture. The present student population in the Faculty of Agriculture and Horticulture numbers 240. Developments envisaged at Sutton Bonington in the near future provide for a considerable extension of the facilities in the Horticultural Department. A scheme costing £15,000 has been approved in this connexion and is being assisted by the Ministry of Agriculture. As a result of this development, Nottingham will have a centre of higher agricultural education that will fit into the general scheme of agricultural education that is now being planned for the country as a whole. So far as horticulture is concerned, Nottingham will have to cater for the educational needs of the northern half of England.

Birds of Heligoland

MINOR discharges were used to arouse the seabirds of Heligoland so as to avoid their destruction in the greater explosions which marked the destruction of the fortifications of the island. The island is to revert to its pre-war use as an ornithological centre for migration studies. The nesting birds of Heligoland are comparatively few: its importance in the North Sea off the Elbe estuary lies in the facilities it has offered for the study of bird migration during spring and autumn. The Heligoland design of bird recovery trap, originally adapted for bird-ringing pursuits off South Wales, is being utilized in the formation of a chain of independent bird-study stations around the British Isles at Fair Island, the Spurn, Lundy Island, Milford Haven and elsewhere. As many as 9,000 starlings were caught, marked and released on Heligoland during one pre-war migration in the studies organised by the German State Biological Bureau under the direction of Dr. Rudolf Drost and Dr. Shildmacher. In nine days on one occasion 1,130 birds were ringed: these included 271 blackbirds, 220 song thrushes, 105 redbreasts and 144 skylarks. The German Ministry of Agriculture helped to finance these studies.

German Scientific and other Periodicals

THE Association of Special Libraries and Information Bureaux has prepared a classified list of German periodicals, excluding newspapers, official gazettes, local organs of political parties, trade unions and churches, devotional literature and popular periodicals (from the Association, 52 Bloomsbury Street, London, W.C.1. 1s.). The list is largely based on two published bibliographies, "Die deutsche Presse, 1946" and "A Check-list of Current Serials in the United States Zone of Germany". Orders for such periodicals for not less than six months subscription will be accepted on behalf of H.M. Stationery Office by the Secretary, Enemy War-time Publications Requirements Committee, Control Commission for Germany and Austria, Norfolk House, St. James's Square, London, S.W.1 (see also *Nature*, March 15, p. 366).

Spectrographic Terminology

THE Spectrographic Discussion Group at Glasgow has produced a pamphlet (University Press, Aberdeen, 1946) entitled "Suggested Definitions of Terms used in Spectrographic Analysis". This recommends a set of symbols for various spectrographic constants and suggests definitions of a large number of terms used in this type of work. The chairman of the group, Mr. S. D. Steele (c/o Messrs. Babcock and Wilcox, Renfrew, Scotland), offers to send a free copy of the pamphlet to interested persons and will welcome criticism and suggestions. The proposed symbols do not, in general, appear to conform to the principles laid down by the Joint Report of the Chemical, Faraday and Physical Societies (1937).

Fourth International Congress for Microbiology

THE International Association of Microbiologists is organising the Fourth International Congress for Microbiology, to be held at Copenhagen during July 20–26, 1947. General meetings will be addressed by Dr. F. C. Bawden (Rothamsted Experimental Station) on viruses, Prof. S. A. Waksman (New Jersey State Agricultural Experiment Station) on antibiotics and life, Prof. C. H. Werkman (Iowa State College) on the assimilation of carbon dioxide, and Prof. Ø. Winge (University of Copenhagen) on yeast in modern genetics. The nine sections of the Congress will be devoted respectively to general microbiology, medical and veterinary bacteriology, viruses and virus diseases, serology and immunology, variation and mutation in micro-organisms, plant pathology and mycology, soil and water microbiology, dairy and food microbiology, and industrial microbiology. The president of the Congress is Dr. Th. Madsen; and the honorary general secretary is Dr. M. Bjørneboe, Kommunehospitalet, Copenhagen. Those wishing to take advantage of official arrangements for hotel accommodation should communicate with the honorary general secretary not later than May 15.

Institute of Industrial Administration Summer School

THE Institute of Industrial Administration has arranged a summer school for 'management teachers', to be held at Oriel College, Oxford, during July 26–August 2. The purpose of the School is to give selected persons, responsible for the teaching of management subjects (full- and part-time), an opportunity to explore the syllabuses proposed by the Ministry of Education Committee on Education for Management and to discuss the practical teaching problems arising from it. The School will be residential and will be conducted in lecture and tutorial sessions. The chairman of the School is Major L. Urwick, chairman, Ministry of Education Committee on Education for Management. Guests will include delegates from the United States to the Eighth International Congress for Scientific Management, Stockholm, in July. The Ministry of Education will be represented, and the 'Assembly' address will be delivered by Sir David Ross, provost of Oriel College. Application for forms and programmes should be made to: Assistant Secretary (Education), Institute of Industrial Administration, Artillery House, Artillery Row, London, S.W.1.

Summer School in Relaxation Methods

A SUMMER school in 'Relaxation Methods' will be held at the Imperial College of Science and Technology, London, during the four weeks July 8–August 1. It would seem that there is no great difficulty in acquiring such knowledge of the relaxational technique as is required to solve ordinary engineering problems (frameworks, electrical networks, etc.), so it is proposed this year to concentrate on problems involving partial differential equations in two independent variables. The course will consist of more or less formal lectures, with numerous examples to be solved under supervision; lectures will be given on Tuesdays–Fridays only, but facilities for practical work will be also provided on Mondays and (if requested) on Saturday mornings. Further particulars can be obtained from Mr. D. N. de G. Allen, Imperial College, London, S.W.7.

School of Cosmic Physics, Dublin

THE inaugural meeting of the School of Cosmic Physics in the Dublin Institute for Advanced Studies was held on March 27. The following have been appointed by the President, on the advice of the Government of Eire, to be senior professors of the School: Dr. L. W. Pollak, senior meteorological officer, Department of Industry and Commerce, Eire (from April 1); Dr. L. Jánossy, I.C.I. fellow at the University of Manchester (from July 1, 1947); and Dr. H. A. Brück, assistant director, Cambridge Observatory (from October 1, 1947).

University of London: Appointments

THE following appointments in the University of London have been announced: Prof. S. W. Wooldridge, professor of geography at Birkbeck College, to the University chair of geography tenable at King's College, as from October 1; Dr. P. R. Crowe, senior lecturer in geography in the University of Glasgow, to the University readership in geography tenable at Queen Mary College, as from October 1; Dr. Alfred Schweitzer, lecturer in physiology in the University of Leeds, to the University readership in experimental physiology tenable at University College, as from October 1; Mr. A. W. Skempton, senior lecturer in civil engineering at the Imperial College of Science and Technology, to the University readership in soil mechanics tenable at the College, as from October 1, 1946; Mr. J. R. Gilmour, to the University readership in morbid anatomy tenable at London Hospital Medical College, as from October 1. The title of professor of mathematics in the University has been conferred on Dr. W. G. Bickley, in respect of the post held by him at the Imperial College of Science and Technology.

Colonial Service Appointments

THE following appointments have been made in the Colonial Service: Capt. C. N. Coombes, agricultural economist, Gold Coast; W. B. Tevendale, geologist, Gold Coast; Flight-Lieut. K. V. W. Nicholls, meteorological officer, Malaya; Flight-Lieut. R. C.

Bannister, professional assistant, Royal Observatory, Hong Kong; G. J. Lockley, fishery officer, Tanganyika; H. E. C. Lushington, senior assistant conservator of forests, Ceylon, to be conservator of forests, Ceylon; E. W. March, assistant conservator of forests, Ceylon, to be conservator of forests, Jamaica; L. G. T. Wigg, assistant conservator of forests, Tanganyika, to be senior assistant conservator of forests, Tanganyika.

Recent Comets

COMET RONDANINA–BESTER (1947*b*) was discovered by Rondanina and independently by Bester at Bloemfontein on March 24. Its magnitude at the time of discovery was 11, and its daily motion was rather rapid, suggesting that it was fairly close to the earth. Dr. L. E. Cunningham computed an orbit and a short ephemeris which has been continued by Dr. G. Merton; these are given below.

T 1947, May 20·913 U.T.
ω 303° 41′ }
Ω 353 13 } 1947·0
i 39 22 }
q 0·5599

EPHEMERIS

1947	0h R.A.	Dec.	r	ρ	Mag.
May 3	2h 21·1m	−27° 22′			
7	18·9	22 02	0·643	0·728	9·5
11	17·7	16 55			
15	17·7	12 00	0·576	0·861	9·4
19	19·1	7 00			
23	21·9	2 28	0·562	1·001	9·6
27	26·0	+ 2 05			
31	31·4	6 26	0·605	1·137	10·2

Comet Bečvář (1947*c*) was discovered on March 27 by Dr. Bečvář, Observatory Skalnaté Pleso. He described it as diffuse, without central condensation or nucleus, and its magnitude was 9. Dr. Cunningham has computed an orbit and ephemeris for this comet also, the ephemeris having been extended by Dr. Merton.

T 1947, May 3·971 U.T.
ω 182° 25′ }
Ω 322 35 } 1947·0
i 128 58 }
q 0·9609

EPHEMERIS

1947	0h R.A.	Dec.	r	ρ	Mag.
May 3	6h 0·9m	+22° 52′			
7	1·6	19 40	0·962	1·362	10·5
11	2·1	16 53			
15	2·4	14 28	0·980	1·550	10·9
19	2·6	12 18			
23	2·8	+10 21	1·017	1·719	11·3

The Night Sky in May

FULL moon occurs on May 5d. 04h. 53m. U.T., and new moon on May 20d. 13h. 44m. The following conjunctions with the moon take place: May 6d. 00h., Jupiter 0·4° N.; May 18d. 09h., Mars 2° N.; May 18d. 10h., Venus 1° N.; May 24d. 23h., Saturn 4° S. In addition to these conjunctions with the moon, Venus is in conjunction with Mars on May 17d. 12h., Venus being 1·0° S. Mercury is in superior conjunction on May 15. Towards the end of the month, the planet sets 1½ hours after the sun and can be seen as an evening star. Venus rises about half an hour before the sun on May 1 and 50 min. before sunrise on May 31, and can be seen in the eastern sky, stellar magnitude −3·3. Mars can be observed as a morning star for a short period before sunrise, rising at 4h., 3h. 21m., and 2h. 41m. at the beginning, middle and end of the month respectively. Jupiter, in the constellation Libra, is visible until the early morning hours, setting after sunrise during the first half of May. Saturn, in the constellation Cancer, can be seen only during the early part of the night, setting at 1h. 36m., 0h. 43m., and 23h. 43m., at the beginning, middle and end of the month, respectively. Only one occultation of stars brighter than magnitude 6 takes place in the month, on May 23d. 22h. 10·5m., *A* Gemi. (*D*). The latitude of Greenwich is assumed, and *D* refers to disappearance. A total eclipse of the sun on May 20 is visible over portions of South America and central Africa, and preparations have been made to observe it (see *Nature*, March 1, p. 287); the British expedition has been cancelled following the deaths of two of the party in an aeroplane crash.

Announcements

THE Lord President of the Council has approved the appointment of Dr. Franklin Kidd, superintendent of the Low Temperature Research Station, as director of food investigation, Department of Scientific and Industrial Research, in succession to Dr. C. S. Hanes, who has become head of a unit of biochemistry that is being set up at the University of Cambridge by the Agricultural Research Council. Dr. E. C. Bate-Smith, senior principal scientific officer at the Low Temperature Research Station, has been appointed superintendent of the Station.

DR. GEOFFREY GEE has been appointed director of research of the British Rubber Producers' Research Association in succession to Mr. J. Wilson.

DR. H. CULLUMBINE has been appointed professor of physiology in the University of Ceylon, which came into existence in 1942 by the incorporation of the Ceylon University College (founded in 1921) and the Ceylon Medical College (founded in 1870). During the War, Dr. Cullumbine was engaged in research in the Physiology Department of the Chemical Defence Experimental Station, Porton, and since then he has worked in the Department of Pharmacology, University of Manchester.

THE fourth Mercer Lecture of the Society of Dyers and Colourists will be delivered on May 2 at the Royal Technical College, Glasgow, by Mr. E. J. Bowen, of University College, Oxford, who will speak on "Colour and Constitution: Absorption of Light by Chemical Compounds".

THE annual malaria control courses for planters, miners and others are to be resumed at the London School of Hygiene and Tropical Medicine. This year the course will be held at the School during June 23–27. The course is free. Applications to attend should be sent as early as possible to the Organising Secretary, Ross Institute of Tropical Hygiene, Keppel Street, Gower Street, London, W.C.1.

THE Trustees of the Ramsay Memorial Fellowships for chemical research will consider at the end of June applications for one fellowship of value £300 per annum, tenable for two years. Particulars can be obtained from the joint honorary secretaries, Ramsay Memorial Fellowships Trust, University College, London (Gower Street), W.C.1, to whom applications must be forwarded not later than May 31.

THE suggested summer school in X-ray crystallography at Manchester (see *Nature*, March 22, p. 398) will be held during September 1–12. Applications to attend must be received not later than May 12.

ERRATUM. In *Nature* of March 22, p. 387, review of "The Milky Way": the longest axis of the Galaxy is more than 100 thousand light-years, not 100 million light-years as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Neutron Experiments of the Physical Laboratory of Groningen

In the beginning of 1940, a few months before the occupation of Holland by the Germans, we started some neutron experiments in this Laboratory (see ref. 1). To determine neutron energies the well-known boron absorption method was applied. Following Frisch's example[2], boron was used not as a compound but in the pure amorphous state. This boron arrived in March 1940 in Groningen from the British Drug Houses, Ltd. As it yielded nearly the same results as a sample of amorphous boron from Merck (Germany) which we had still in the laboratory, we had not the slightest suspicion that our results could be spoiled by too high an amount of impurities.

That this was really the case could be anticipated as soon as the new results for the resonance energies of silver and other elements, which had been found by the time of flight method, had been published[3,4,5].

Prof. Wiebenga, who kindly made an analysis of the boron we used in our neutron absorption experiments, found an impurity content of not less than 39 per cent. From this it might be concluded that the resonance energies hitherto published from our laboratory should be multiplied by $(0{\cdot}61)^2 = 0{\cdot}37$. As has been shown by the authors cited above, however, the neutrons suppressed by cadmium have in the mean an energy of 0·041 eV. instead of being really thermal neutrons, as was generally assumed hitherto. We used Rasetti's value of $\sigma_B = 4{\cdot}7\ E^{-1/2}$ cm.^{2}/gm.[6], whereas the mean of the values found by the authors quoted in refs. 3, 4 and 5 is $6{\cdot}4\ E^{-1/2}$ cm.^{2}/gm. We therefore conclude that our resonance energies should be multiplied by a factor $1{\cdot}85 \times 0{\cdot}37 = 0{\cdot}69$ to reduce them to their scale. This gives for the resonance energy of silver $0{\cdot}69 \times 8{\cdot}2 = 5{\cdot}7$ eV., in excellent agreement with their results (5·8 and 5·1 respectively).

In a paper soon to be published in *Physica* we shall deal in more detail with the other numerical data of our papers. Here it may be remarked that the general conclusions we arrived at remain valid, since the same correction has to be applied to all resonance energies.

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Hl. de Vries
H. Groendijk

Natuurkundig Laboratorium
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Feb. 17.

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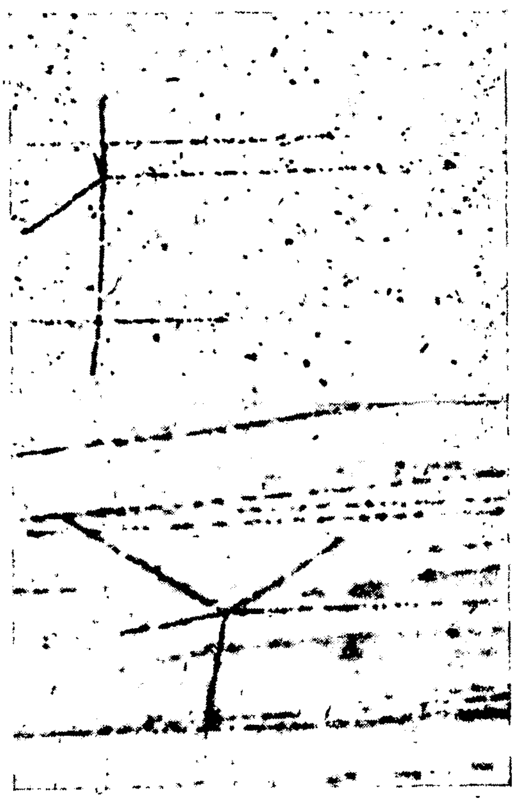
Disintegration of Nitrogen into Four α-Particles by Collision with Deuterons

We have recently exposed photographic plates, coated with the Ilford 'Nuclear Research' emulsions, to the 9 MeV. deuteron beam delivered by the Liverpool cyclotron. The deuterons were allowed to pass into the surface of the emulsion at a small angle of glancing incidence, and an exposure of less than 0·01 sec. was found to be sufficient to give a convenient number of tracks per unit area of the emulsion. In making measurements of the lengths of the tracks of the deuterons, we found, in addition to numerous forked tracks due to collision of deuterons with protons, examples of disintegrations produced by the entry of primary particles into nuclei of light elements, such as carbon, oxygen and nitrogen, present in the emulsion.



Two examples of a particularly interesting type of disintegration are shown in the accompanying photomicrograph. In the top photograph it will be seen that three deuterons have entered the emulsion, and that one of them has reacted with a nucleus and caused the emission of four particles. The lower photograph shows a similar event. The grain spacing in the tracks of the secondary particles is characteristic of α-particles and, since nitrogen is present in the gelatine, we attribute the disintegration to the reaction

$$N_7^{14} + H_1^2 \rightarrow 4\,He_4^2.$$

The possibility of this reaction was first mentioned by Cockcroft and Lewis[1], who observed a continuous distribution of α-particles from nitrogen bombarded with deuterons; but they could not establish the fact of its occurrence in their experimental conditions.

We have now observed five events of this type, and the correctness of our interpretation can be proved by applying the principles of the conservation of mass-energy and of momentum. The lengths and spatial orientations of the tracks were determined, by the usual methods employed in the photographic technique, and the energy and momentum of the corresponding particles deduced from the range-energy curve for the emulsion. The units of momenta are calculated according to the formula $M = \sqrt{2mE}$, where E is the energy in MeV., and m the mass number of the nucleus.

For each particular disintegration we define a system of rectangular co-ordinates OX, OY, OZ, in which the origin O is taken to be the centre of disintegration and OX coincides with the direction of motion of the incident deuteron. The spatial orientations of the tracks enable us to determine the values of the momenta M_x, M_y, M_z, of the individual α-particles. In those cases in which all the particles end in the emulsion, the results show that the sum of the components M_y and M_z of the four α-particles produced in each particular disintegration differs from zero by amounts less than the probable error, while the sum of the components M_x is equal to the momentum of the deuteron, M_d. In some cases one of the particles leaves the emulsion, and its momentum, and hence its energy, has then been determined by applying the relations $\Sigma M_y = 0$, $\Sigma M_z = 0$. The results of measurements on three of the disintegrations are given in the table.

No.	ΣM_x	M_d	ΣE_α (MeV.)	E_d (MeV.)	Q (MeV.)
1	5·61	5·75	14·20	8·29	5·91
2	5·49	5·69	14·33	9·10	6·23
3	5·80	5·52	13·19	7·58	5·61

The difference between the sum of energies of the α-particles, ΣE_α, and the energy of deuterons, E_d, gives us the Q value for the reaction. The mean value, $Q = 5 \cdot 92$ MeV., differs from that calculated from the masses only by 0·40 MeV.

The successful application made in the present experiment serves to emphasize the important contribution which the photographic method has to offer in the detailed study of nuclear disintegrations. Apart from the Wilson cloud chamber, which is very slow, this is the only method in which all particles resulting in the disintegration can be recorded simultaneously. This, therefore, permits the application of the principle of the conservation of momentum in addition to that of conservation of energy. The scope of the method, for experiments of this type, is clearly very great.

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Feb. 20.

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Elementary Photochemical Process in Halides of Bivalent Metals

IN 1929, Hilsch and Pohl[1] discovered an elementary photochemical process in the crystals of halides of *monovalent* metals, owing to a lucky choice of substances and to the application of an extremely subtle method. The assumption of the transition of the electron from the halogen ion to the ion of the metal in the halide crystals of monovalent metals was described first by Fajans[2] and also by Sheppard and Trivelli[3].

A similar elementary process takes place in the absorption of light in aqueous and alcohol solutions of alkali-halogen salts, as was stated by Franck and Scheibe[4] and confirmed by Butkow[5].

So early as 1937, one of us compared the long-wave edges of the spectra of calcium chloride, magnesium chloride and magnesium bromide crystals[6] with the spectra of the vapours[7] of these salts and directed attention to the fact that the shift of the long-wave edges of the first bands in the transition from the crystal to the vapour, as well as the corresponding shifts of the absorption bands of cæsium chloride, bromide and iodide, coincide (approximately) with the sublimation heats of the corresponding salts.

Proceeding from this fact, the hypothesis was set forth[8] that the elementary photochemical process taking place in the halide crystals of *bivalent* metals consists in the transition of an electron from the halogen ion X^- to the ion of the bivalent metal M^{++} with the formation of the subhalide (M^+X^-).

In order to check this hypothesis, consider the following cyclic process:

$$\begin{tikzcd}
{[M^{++}X_2^-]} \arrow[r, "{[h\nu]^{gr}_{\text{theor}}}"] \arrow[d, "Q^0_{MX_2}"'] & {[M^+X^-]X} \arrow[r, "Ad^0_X"] & {[M^+X^-] + (X)_0} \arrow[d, "Q^0_{MX}"] \\
{[M] + [X_2]} \arrow[rr, "\frac{1}{2}S^0_M + \frac{1}{2}D^0_{X_2}"'] & & {[M] + \frac{1}{2}[X_2] + (X)}
\end{tikzcd}$$

where $[h\nu]^{gr}_{\text{theor}}$ denotes the quantum of radiant energy corresponding to the long-wave edge of the first absorption band of the MX_2 crystal; $Q^0_{MX_2}$ and Q^0_{MX}, the reaction heats of the formation of MX_2 and MX respectively at the temperature of absolute zero; S^0_X and $D^0_{X_2}$ have the usual Born–Haber cycle meaning Ad_X, adsorption energy of the halogen atoms X in the crystalline lattice of the subhalide $[M^+X^-]$.

From the cyclic process we have:

$$[h\nu]^{gr}_{\text{theor}} = Q^0_{MX_2} - Q^0_{MX} + \tfrac{1}{2}S^0_{X_2} + \tfrac{1}{2}D^0_{X_2} - Ad^0_X \quad (1$$

The comparison of the experimentally determined first absorption bands of MX_2 crystals with the long wave edges of these bands, calculated theoretically from equation 1, is given in the accompanying table and in Fig. 1, and has justified the above hypothesis with respect to *highly polar* compounds, MX_2.

Fig. 2 gives a schematical representation of the absorption spectra of crystals of the *weakly polar* compounds CdX_2 and ZnI_2.

With the help of equation 1, we have calculated the values of the energies $[h\nu]^{gr}_{\text{theor}}$ also for the weakly polar compounds, which correspond to the formation of a non-excited halogen atom (these values of th energy in Fig. 2 are represented by a vertica arrow, ↑).

We have calculated also the energy which corresponds to the transition of the electron from the

MX_2	$Q^0_{MX_2}$ [9]	$1/2\ S^0_{X_2}$	$1/2\ D^0_{X_2}$ [10]	Q^0_{MX} [11]	Ad^0_X	Long-wave edge		Position of maximum
						$[h\nu]^{gr}_{theor}$	$[h\nu]^{gr}_{exp}$	$[h\nu]^{max}_{exp}$ [12]
$BaCl_2$	8·97	—	1·27	2·65	0·05	7·54	6·9	7·7
$CaCl_2$	8·36	—	1·27	2·26	0·05	7·35	7·0	8·1
$MgCl_2$	6·62	—	1·27	0·78	0·05	7·06	7·05	7·6
$BaBr_2$	7·89	0·18	0·98	2·43	0·05	6·57	5·9	7·3
$MgBr_2$	5·33	0·18	0·98	0·43	0·05	6·01	6·0	6·5

(All values are in e-volts)

halogen ion to the ion of the metal, with the formation of an *excited* halogen atom:

$$[h\nu^*]^{gr}_{theor} = [h\nu]^{gr}_{theor} + A_X,$$

where A_X denotes the *excitation* energy of the halogen atom[13]. The values of the energy $[h\nu^*]^{gr}_{theor}$ in Fig. 2 are represented by circles, O.

A consideration of Fig. 2 leads one to the conclusion that the first absorption bands in weakly polar MX_2 crystals are connected with the transition of the electron from the halogen ion to the metallic ion with the formation of an excited halogen atom. It should be noted that in the absorption of light by weakly polar MX_2 molecules in the vapour state, the halogen atom is split off from the MX_2 molecule also in the excited state[14]; this is not so in the case of halides of bivalent lead, cobalt and nickel[15].

The absorption of light by the weakly polar MX_2 halides both in the gaseous and the crystalline state is thus accompanied by the formation of excited halogen atoms, which we believe to be connected with the fact that cadmium chloride, bromide and iodide and zinc iodide are characterized by *layer* crystal lattices, representing a type of lattice intermediate between the co-ordination and molecular types.

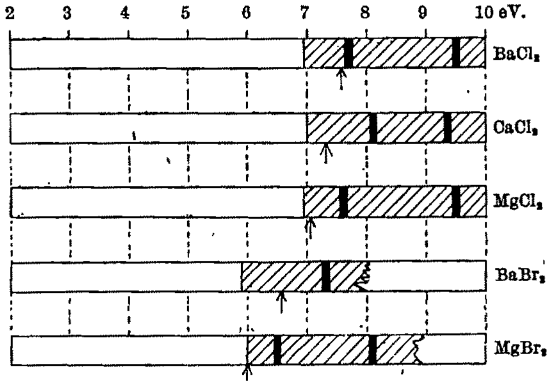

Fig. 1. Thick black line, maximum of absorption; hatched area, long-wave edge of spectrum; ↑, calculated value of $[h\nu]^{gr}_{theor}$

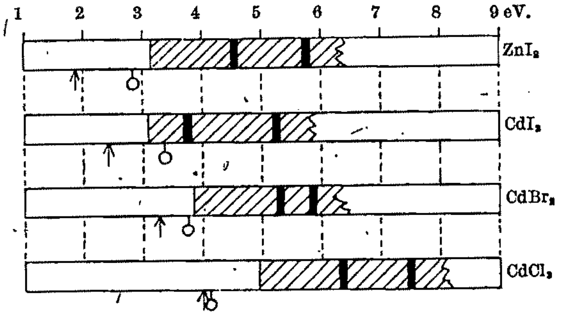

Fig. 2. Thick black line, maximum of absorption; hatched area, long-wave edge of spectrum; † and O, calculated values of $[h\nu]^{gr}_{theor}$ and $[h\nu^*]^{gr}_{theor}$

In the case of highly polar MX_2 compounds (M = Ba, Ca, Mg), the first absorption band, both in the crystalline and the gaseous phase, is connected with the formation of non-excited halogen atoms.

Finally, intermediate cases are possible; for example, thallium chloride and bromide, in which, in the crystalline state (lattice of the CsCl type), the absorption of light leads apparently to the formation of non-excited halogen atom, while in the gas phase the molecule is photodissociated[16] with the formation of excited halogen atoms. This is due to the fact that, owing to the high ionization potential of the thallium atom, the polarizing action of Tl^+, according to Fajans' general theory of ionic polarization, is so large that the molecules of thallium chloride, bromide and iodide in the gaseous state are atomic (and not ionic).

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Jan. 1.

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Oxidation Activity of Selenium Dioxide

In a recently published review on the mechanisms of oxidation, W. A. Waters[1] states that scarcely any evidence can be adduced for the mode of action of selenium dioxide. Since the discovery[2] of its specific oxidative activity, the interactions of selenium dioxide with more than three hundred organic compounds[3] of the most diverse character have been investigated: a common stoichiometric mechanism could scarcely be expected. There is, however, evidence which suggests the direction in which we should look for an explanation.

Many of the reactions have one feature in common, namely, the oxidation products are highly reactive substances; they must, therefore, have been formed initially in a low-energy state, otherwise they would certainly have suffered further oxidative degradation. Spectrographic investigations[4] have shown that in the luminous, high-temperature oxidation of organic gases and vapours and of ammonia in selenium dioxide vapour, none of the electronic energy-levels in the product molecules is excited; the radiation emitted consists of diffuse bands and a continuous region in the visible (5620–4600 A.), with no trace of radiation in the ultra-violet. These bands are probably due to selenium or possibly SeO molecules. The phenomenon indicates that when the activated reaction complex breaks down, the greater part of the energy of the reaction and the activation energy remains with the selenium. It is not improbable that similar phenomena occur in the condensed phase at somewhat lower temperatures, where visible radiation would not be expected.

The unique oxidative reactivity of selenium dioxide probably depends upon this electronic property of the selenium. The structural characteristics of the organic molecule undergoing oxidation will govern the formation of the necessary unstable intermediate compound or activated complex.

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Feb. 25.

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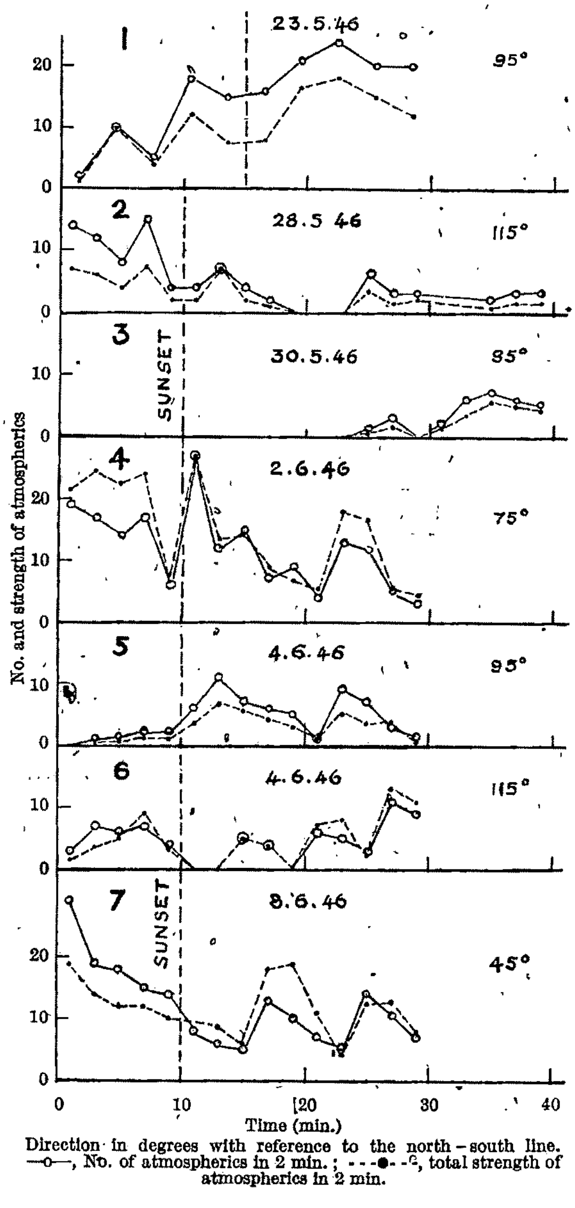
Location of Thunderstorm Centres from Directional Observations of Atmospherics During Sunrise and Sunset

IT has been known for many years[1] that there are anomalies in the number and strength of the *distant* atmospherics observed during the sunrise and the sunset periods. Investigations[2] in this laboratory on distant atmospherics on high and medium radio frequencies showed unmistakable maxima during sunrise and sunset. Previously, Potter[3] had observed similar effects. The effect of sunset on atmospherics was also reported by Subba Rao[4]. Besides Potter and Namba[5], Khastgir[6] recently offered an explanation of the sunrise and sunset effects observed. The object of the present communication is to show that on this theory a simple method can be devised for the location of a thunderstorm centre which gives rise to atmospherics by observing the time of occurrence of the maximum in the strength of the atmospherics, when the distant thunderstorm prevails over a period of time covering sunrise or sunset. The results of some directional observations of atmospherics at about sunset are also given in this connexion.

From a distant thunderstorm centre in the troposphere, the atmospheric pulse of waves is usually reflected from the ionosphere and reaches the receiving point. In the small hours of the morning, it is evident, the intensity of the down-coming waves, originally coming from the distant source of atmospherics, increases gradually with the slowly decreasing ionization in the *E*-layer until, on the incidence of the solar rays, at sunrise, there is a great increase in the ionization, causing a large fall in the intensity owing to greater absorption in the layer and also to greater deviation of the rays due to higher electron concentration. This causes a maximum in the strength of the atmospherics about the time of sunrise. Before sunset, again, the intensity of the down-coming waves gradually increases, due to a continuous decrease in ionospheric absorption, until at the instant of the withdrawal of the solar rays at sunset the intensity suddenly falls. This is because when the ionizing solar rays are withdrawn there is a perceptible decrease in the *E*-layer ionization, and the down-coming waves are much less deviated and necessarily fail to reach the receiving point. This gives a maximum in the strength of the atmospherics about sunset time. Afterwards, however, the smaller ionospheric absorption asserts itself, causing at first a slow decrease of intensity and ultimately an increase.

The work on the early morning increase of *E*-layer ionization by Mitra and his co-workers[7] has shown that the ionization begins to increase, not when the early morning solar rays strike the *E*-layer by grazing the earth's surface, but when the rays strike the layer by grazing the surface of the ozonosphere at a height of 35 km. above the earth. The sun's rays, in order



Direction in degrees with reference to the north – south line. —o—, No. of atmospherics in 2 min.; - - -●- -○, total strength of atmospherics in 2 min.

to produce ionization in the E-layer, should, therefore, pass over the ozone region, so that radiations of the shorter wave-lengths will not be absorbed by the ozone. Keeping this conclusion in view, the time of occurrence of the increase of ionization in the E-layer by the sun's rays at dawn or of the decrease of ionization when the solar rays are withdrawn at dusk can be found with reference to the ground sunrise and sunset times. This would correspond to the time of occurrence of the maximum of atmospherics observed about the time of sunrise or sunset.

If the angle between the two tangents on either side of the ozonosphere from the point of ionospheric reflexion is denoted by $(180° - \varphi)$, it can be shown that the difference between the instant of ground sunrise or sunset and the time of occurrence of the atmospherics maximum is given by : $\Delta T = 4\varphi \pm (l_s - l_r)$, where l_s and l_r denote the longitudes of the source of atmospherics and the receiving point. The value of φ in the above relation can be calculated approximately from the known values of the heights of the E-layer and the ozone layer and from the location of the receiving point. If now the latitude λ_r and longitude l_r of the receiving point are known, the latitude λ_s and the longitude l_s of the source of atmospherics can be easily determined from the observed value of ΔT, remembering, however, that the observed angle of arrival of the atmospherics is given by $\tan\alpha = \dfrac{\lambda_s \sim \lambda_r}{l_s \sim l_r}$. Having thus obtained the location, the distance of the thunderstorm centre can be easily found.

A few typical experimental results on 1,000 metres on the subject are shown in the accompanying graphs. Here the number and total strength of the atmospherics (in arbitrary units) for 2 min. are plotted against time for specified directions. One distinct case of successive double reflexion simultaneously occurring with the usual single reflexion between the source of atmospherics and the receiving point is shown in curve No. 6, where there are three peaks at regular intervals. The location of the source of atmospherics in such cases is obtained with reference to the middle peak. It is likely that curves 5 and 7 represent two other similar cases, where possibly the farthest of the three successive peaks is not observed. The location and the distance of the thunderstorm centres for the cases illustrated are given in the accompanying table. The experiments were performed with the cathode-ray tube D.F. equipment of the Council of Scientific and Industrial Research (India), to whom our thanks are due.

No.	Location	Distance in miles	No.	Location	Distance in miles
1	(*a*) 100·65° E. 22·8 N.	646	4	(*a*) 97·9° E. 25·7 N.	497
	(*b*) 78·9 E. 22·7 N.	744		(*b*) 101·9 E. 26·8 N.	755
	(*c*) 81·65 E. 22·9 N.	563		(*c*) 103·9 E. 20·1 N.	896
2	(*a*) 96·9° E. 20·7 N.	473	5	97·9° E. 23·0 N.	484
	(*b*) 102·9 E. 17·9 N.	910	6	98·9° E. 23·3 N.	542
	(*c*) 77·9 E. 17·9 N.	910			
3	(*a*) 91·4° E. 23·8 N.	118	7	96·9° E. 30·2 N.	605
	(*b*) 95·9 E. 24·2 N.	424			

Signal strength observations at Dacca[8] of the Calcutta short-wave station during the sunset period showed a maximum at the time predicted by the present theory of sunrise and sunset effects.

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Feb. 8.

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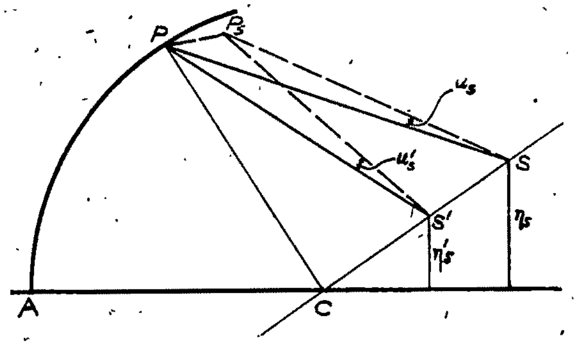
An Optical Magnification for Finite Objects

IF N, u, η are the refractive index, the paraxial angle, and the size of object respectively, and dashes denote these quantities in the image space, then the magnification formula,

$$m = \frac{\eta'}{\eta} = \frac{Nu}{N'u'}, \quad . \quad . \quad . \quad (1)$$

is valid for limiting by small values of η only, with the same condition applying to the invariance of the quantity $Nu\eta$ throughout the system. It is, however, possible to derive a similar expression which is valid for finite object sizes.



In the diagram, PS, PS' are incident and refracted principal rays, S, S' being the foci of close sagittal rays P_sS, P_sS'. It is known that S, S' lie on the auxiliary axis $CS'S$. Let the heights of S, S' be η_s, η_s'; these will be called sagittal objects and image heights. Then the magnification is

$$m = \frac{\eta_s'}{\eta_s} = \frac{CS'}{CS} = \frac{s' \sin I'}{s \sin I},$$

where $s = PS$, $s' = PS'$; $I = \angle SPC$, $I' = \angle S'PC$. If now the sagittal paraxial angles $u_s = \dfrac{PP_s}{s}$, $u_s' = \dfrac{PP_s}{s'}$ be introduced, one has

$$\frac{\eta_s'}{\eta_s} = \frac{Nu_s}{N'u_s'}.$$

Thus η_s', η_s are related by the sagittal magnification $m_s = \dfrac{Nu_s}{N'u_s'}$, and the quantity $Nu_s\eta_s$ is invariant irrespective of the magnitudes of η_s and η_s'.

It is also easy to prove the results by noting that the sagittal image heights describe object and image circles on rotation of the diagram about AC. The magnification of each element of the object circle so obtained is the same and equal to m_s. Thus the perimeters of the two circles being related by the sagittal magnification, so must their radii be similarly related.

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W. Watson and Sons, Ltd.,
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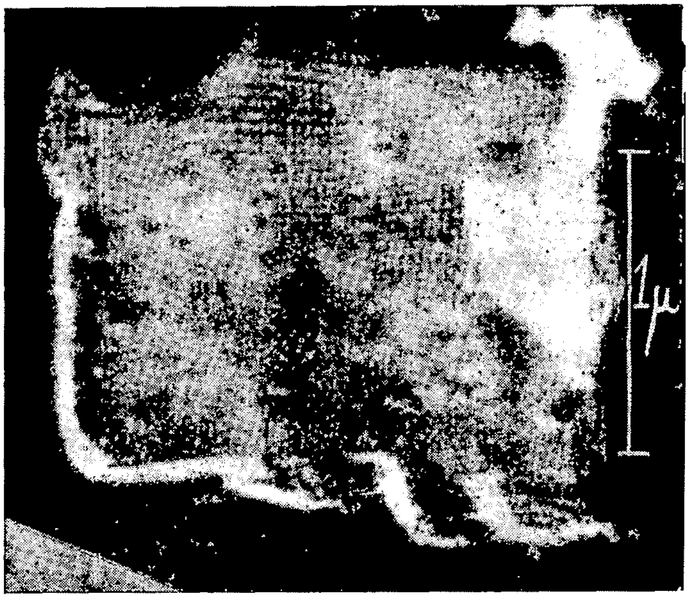
Feb. 6.

Electron Microscopy of Tobacco Necrosis Virus Crystals

Electron microscopy has shown the regular way in which the elementary particles, or molecules, of the southern bean mosaic virus are arranged in its crystals[1]. Not all crystallizable viruses are equally easy to examine in this fashion; but we have found that satisfactory photographs can be obtained of single crystals of a strain of the tobacco necrosis virus. They differ from the bean mosaic virus electron micrographs in a number of interesting and instructive ways.



Electron micrograph showing the particle arrangement over the face of a single tobacco necrosis virus crystal. × c. 38,000

The crystals were of microscopic size obtained from a purified solution of a newly isolated member of this group of viruses[2], prepared by high-speed centrifugation followed by salt precipitation. Replicas[3] of a dilute suspension of the crystals in half-saturated magnesium sulphate were made by spreading a small drop on a clean microscope slide, coating the dried spread with an obliquely evaporated gold film, reinforcing the gold with thin collodion and floating the combined film from the slide on to water for cutting and mounting on screens. The preparations in this form were given a final vertical deposit of a few angström units of beryllium to enhance their stability under the electron beam.

The molecular array over the face of a typical microcrystal of this necrosis virus can be seen in the accompanying reproduction. In the many fields examined, crystals have always been covered with a haze which probably is to be attributed to impurities remaining in the preparation. Though this interferes with photography at the highest magnifications, it does not obscure many features of the crystalline structure. The molecular net of nearly all the necrosis virus crystals that have been photographed suggest, as does the one shown here, a frayed piece of wire screening. The extensive irregularities of these nets have prevented very accurate determinations of interparticle distances. Nevertheless, measurements across 10–20 molecular rows in undisturbed regions indicate that the same particle separation, c. 275 A., prevails in both the vertical and the horizontal directions. In the bean mosaic crystals the separation is nearly 50 per cent greater in one direction than in the other. The rows of particles are approximately at right-angles, but the net is not strictly cubic. In the crystal illustrated here, its obtuse angle is c. 95°.

The photographs made thus far do not establish with certainty the way succeeding layers of particles overlie one another to build up a crystal. Most of the evidence points to the lattice being simple, though a body-centred arrangement cannot yet be excluded.

Many of the thinnest deposits probably were formed as the crystal suspension dried on the slide. Their particles, too, are in a square network. Regular arrangements having no more than a dozen or so particles on a side are also not uncommon. This ability of the necrosis virus to crystallize directly from solution should make it especially valuable for use in studies of the first steps in crystal formation.

The electron micrography of this virus is being continued; its results will be described in more detail elsewhere.

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National Institute of Health,
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March 8.

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Alloxan Diabetes and the Kidney in the Rat

Jimenez-Diaz, Grande-Covian and De Oya[1] have reported recently that dogs in which the vessels of both kidneys were clamped prior to and for ten minutes following the intravenous injection of 100 mgm./kgm. of alloxan failed to develop either the hyperglycæmia or the uræmia of the controls in which the clamping was omitted. On the basis of this experiment they postulated the existence of some factor in the kidney with which the alloxan must come in contact before it can exert its full diabetogenic effect.

Alloxan is known to exert a specific toxic action on the beta cells of the islets in many species[2]. It was felt that should there be a chemical factor in the kidney necessary to mediate the toxic effect, it would be present in all those species in which the diabetogenic action was observed. We chose the rat to test the hypothesis.

Male and female adult hooded rats, of a strain bred in this laboratory, weighing between 175 and 250 gm., were fasted for twenty-four hours, then operated on under ether anæsthesia. In the control group the abdomen was opened, the inferior vena cava exposed, and injection of 100–175 mgm./kgm. alloxan in aqueous solution made into this vein. In the experimental group, the kidneys were exposed, the pedicles dissected free and the vessels clamped prior to the injection. The clamps were then left in place for ten minutes as described by Jimenez-Diaz and collaborators in their original report. Following this treatment the animals were returned to their cages and allowed food and water *ad lib.* Blood-sugar determinations were made on tail-vein blood samples obtained from the survivors at 24 and 48 hours following the injection. A condensation of the results is shown in the accompanying table; 48-hour blood sugars only are tabulated as the 24-hour and earlier samples were found to be erratic in both groups. Blood-sugar values greater than 130 mgm. per cent were listed as hyperglycæmic in this summary as the sugar method used (Somogyi and Nelson[3]) gives low values corresponding to true sugar. However, only two rats fell into the group with blood sugar 130–150 mgm. per cent; the remainder all displayed levels higher than 250 mgm. per cent. No differences were noted due to different treatment doses used, namely, 175, 150, 140 and 100 mgm./kgm., and all the results are included together in the table.

	Kidneys clamped		Kidneys not clamped	
	No. of rats	Per cent	No. of rats	Per cent
Total	36	100·0	18	100·0
Survivors at 48 hr.	22	61·1	12	66·7
Hyperglycæmic at 48 hr.	18	50·0 81·7*	11	61·1 91·6*

* Percentage of survivors.

Differences between the two groups were not found to be significant when tested with the fourfold table and Fisher's χ^2 method.

A further group of three rats was nephrectomized, following which 275 mgm./kgm. alloxan was injected intraperitoneally in aqueous solution. At 24 hours the animals were sacrificed, blood sugars determined and pancreases sectioned and stained. Typical necrotic changes, disappearance of granules, pyknosis, shrinkage of cytoplasm, were seen in the pancreases of all three animals, although the blood-sugar levels at the time of death were 58, 138 and 216.

A possible mechanism for the effects observed by Jimenez-Diaz and collaborators was suggested to me during the course of the above experiments. Goldner[2] has shown that if a portion of the pancreas is clamped off for as little as five minutes during and subsequent to the injection of alloxan in rabbits, the clamped portion fails to show histological signs of damage while the unclamped portion displays typical necrosis. During the dissection of the renal pedicle in some of the rats, a temporary blanching of the pancreas was observed. This was thought to be due to reflex vasoconstriction. If this same mechanism operates in the dog, only to a more marked degree, it might afford sufficient curtailment of pancreatic blood flow while the alloxan was being inactivated to protect the islets from the toxic action.

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The Renal Factor in Alloxan Diabetes

JIMENEZ-DIAZ *et al.*[1] have recently reported their failure to induce diabetes in dogs by the intravenous injection of alloxan when both renal pedicles were clamped immediately before and for ten minutes after its administration. They concluded that "the contact between alloxan and the kidney is apparently necessary for the display of the full diabetogenic effect". We have repeated these experiments in rabbits and find that alloxan diabetes of the usual degrees of severity is produced when the kidneys are excluded from the circulation by clamping of the renal pedicles.

In our experiments, white domestic rabbits varying in weight from 1·9 to 2·9 kgm. were used. In each case, alloxan in a 5 per cent aqueous solution was administered intravenously in a single dose of 200 mgm. per kgm. of body-weight. Control and experimental animals were always grouped together and injected with the same freshly prepared solution of alloxan. Preliminary study established the fasting blood-sugar level for each animal. Before and for 48 hours after the injection of alloxan, the animals were allowed food *ad lib.*, and non-fasting blood-sugar levels were determined at intervals beginning at 2 hours and thereafter at 4, 8, 12, 16, 20, 24 and 48 hours after the administration of alloxan. Determinations of the fasting blood-sugar levels were made at 72 and 96 hours.

Eight of the fourteen rabbits employed in this experiment were normal control animals treated with alloxan. Six of these eight rabbits became diabetic and two were resistant to the diabetogenic action of alloxan. The blood-sugar content of the diabetic animals varied from 360 to 640 mgm. per cent. Two of the animals that became diabetic had been injected with alloxan while anæsthetized with nembutal and ether. A ninth animal was subjected to similar anæsthesia and, in addition, to the operative procedure of bilateral renal pedicle clamping for 12 minutes with clamps that were known by previous experience to produce complete obstruction of renal blood flow as proved by the absence of bleeding when the renal pedicle was transected. No alloxan was administered to this animal. The blood-sugar returned to a normal level within 8 hours after this operative interference, and remained so thereafter. The remaining five animals were subjected to an identical operation under the same general anæsthesia and, when both renal pedicles were clamped, alloxan was administered. The clamps were allowed to occlude renal blood flow for ten minutes after the end of the injection of alloxan, and then were removed with the re-establishment of renal circulation. Three of the five animals thus treated became diabetic as judged by the fasting blood-sugar level after 96 hours, these levels being 352, 420 and 520 mgm. per cent respectively. It was noted that both control and experimental animals exhibited the usual variability and irregularity of blood-sugar content during the 24-hour period immediately following the administration of alloxan.

In order to test further the existence of the diabetic state, glucose tolerance tests were done several days before and 72 or 96 hours after the injection of alloxan. The test dose consisted of 1·5 gm. of hydrated glucose per kgm. of body-weight, given intravenously in the fasting state as a 20 per cent aqueous solution. The fasting blood-sugar levels at 72 and 96 hours, together with the results of the glucose tolerance tests, demonstrated that all animals that had received alloxan, whether apparently resistant to its action or not, showed a more or less marked impairment of glucose metabolism. This observation was further confirmed by the detection of an alimentary glycosuria in the alloxan-treated animals that had normal fasting blood-sugar levels, and this in turn was found to occur during periods of abnormal postprandial hyperglycæmia.

Some of the animals died or were killed on the fourth or fifth day of the experiment, but the blood-sugar levels of those that survived were followed for varying periods up to four weeks. While in general the level of the blood sugar at 72 and 96 hours was a reliable index of the subsequent course, nevertheless, in one rabbit treated with alloxan alone, and in two subjected to clamping of the renal pedicle and to alloxan injection, there was a gradual reduction of the fasting blood sugar to normal levels. On the other hand, one rabbit that appeared to be non-diabetic 96 hours after clamping of the renal pedicle and alloxan injection became markedly diabetic on the twelfth post-operative day, and was killed on the sixteenth day when the blood-sugar level was 495 mgm. per cent. In our previous experience with alloxan diabetes in the rabbit, we have encountered such anomalies not infrequently.

In histological sections of the pancreas of animals given alloxan while the renal pedicles were clamped, there was found evidence of recent necrosis of the beta cells of the islets of Langerhans indistinguishable from that seen in control animals treated with alloxan alone. Moreover, identical necrosis of the islets of Langerhans was observed in two rabbits injected with the same intravenous dose of alloxan as the animals described above, but immediately after bilateral nephrectomy.

It is obvious that our observations in the rabbit are distinctly at variance with those of Jimenez-Diaz *et al.* in dogs. While the preliminary data that we have presented are quite inadequate to demonstrate that exclusion of the kidney from the circulation has no effect whatever upon the development and course of alloxan diabetes, nevertheless our observations demonstrate clearly that it is possible to produce in the rabbit necrosis of the islets of Langerhans and the development of a typical diabetic state by the intravenous injection of alloxan while the renal circulation is arrested by clamping of the renal blood vessels. We conclude, therefore, that the continuance of renal circulation during, and for a short time after, the injection of alloxan is not essential to the diabetogenic action of alloxan in the rabbit.

It is a pleasure to acknowledge that this investigation was assisted by grants-in-aid from the Cooper Fund of the Faculty of Medicine, McGill University, and from the National Research Council, Canada.

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Practical Three-Hour and Two-Hour Cylinder-Plate Assays for Penicillin

IN the course of experiments designed to stu
cytochemical changes which occur in susceptib
cells under the influence of penicillin, we appli
various stains and reagents to agar plates prepar
as for the standard *FDA* cylinder-plate assa
which is essentially similar to that recommended
Schmidt and Moyer[1]. The technical procedures e
ployed and the cytochemical observations are bei
reported in detail elsewhere, and are interpreted
terms of an equilibrium between sulphhydryl a
disulphide groups[2]. It will suffice here to state th
thresholds for a number of chemical groupings we
shown to exist at the boundaries of zones of inhibiti
on plates seeded with *Staph. aureus NRRL.* stra
No. 313, or with the rough form of *B. subtilis NRR*
strain No. *B*-558, and afterwards exposed to penicilli
It is well known that these test organisms are mo
sensitive to penicillin when they are in the logarithm
phase of growth. Therefore, we found it advantageo
to pre-incubate the seeded plates for three hou
before adding the solutions to be tested[3]. When th
is done, a secondary incubation period of three hou
for *Staph. aureus* or of two hours for *B. subtilis*
sufficient for the minute colonies developed duri
primary incubation to react to the diffusion of pe
cillin so that the thresholds can be located clearly
suitable techniques.

All the techniques which we have used th
sharply delineate the zones of inhibition agree
locating the threshold at the same distance (with
the limits of experimental error) around a cylind
from which a given concentration of penicillin h
been permitted to diffuse for a given length of tim
Therefore, any of these procedures can be applied
practical tools for completing assays of penicill
within two or three hours from the time the unknow
solution is placed on test. A rapid technique, involvi
impregnation of the plates with silver and subseque
physical development, has been shown to give ass
values that agree closely with those obtained by t
longer standard method, requiring sixteen hours
incubation and diffusion[3]. Therefore, plates process

DIAMETERS OF ZONES OF INHIBITION ON PLATES TREATED WI
DIFFERENT REAGENTS

A. Three-hour *Staph. aureus* plates	Units penicillin/c.c. 0·5	 1·0	 2·0	 4·0	 8·
Reagent:					
Sulphite fuchsin (Schiff's)	12·3	13·0	15·0	16·3	17
Ferricyanide, then ferric sulphate	11·5	13·5	15·0	16·5	17
Azo-coupling reagent	12·3	13·3	14·5	16·3	17
Bromo-cresol purple	11·5	14·0	—	16·5	17
Phenolsulphone phthaleine	11·5	12·3	—	15·5	17
Nile blue	11·0	12·0	13·5	16·0	17
Janus green	12·0	13·0	14·0	15·5	17
Methyl green	12·0	13·0	13·5	15·0	17
Safranine O	11·0	12·0	—	15·5	16
Average for the day:					
Observed	11·70	12·90	14·30	15·90	17
Calculated*	11·74	12·93	14·25	15·77	17
Average for standard (physical development)	11·70	12·80	14·50	16·00	17
B. Two-hour *B. subtilis* plates					
Reagent:					
Sulphite fuchsin (Schiff's)	11·60	—	13·40	14·40	15
Ferricyanide, then ferric sulphate	10·25	11·80	13·50	14·50	16
Cadmium acetate	11·0	—	—	14·70	16
Cobalt nitrate	10·80	11·80	13·25	14·50	15
Average for the day:					
Observed	10·92	11·80	13·38	14·53	15
Calculated*	10·77	11·96	13·13	14·44	15
Average for standard (physical development)	10·90	11·80	13·10	14·40	15

*Based on a linear log diameter – log concentration function.

y physical development are used as standards of eference in the accompanying table. Advantages f the methods tabulated above over the silver mpregnation–physical development technique are heir still greater simplicity and rapidity. All the nethods recorded are potentially useful and have een employed frequently in our laboratory.

Whereas processing the assay plates by the technique of physical development previously described nay require fifteen minutes, flooding them with 1 or 2 er cent ferricyanide, draining, and flooding with 1 per ent ferric sulphate reveals the zones within two or hree minutes; the colour reactions which outline he areas of inhibited growth develop immediately vhen plates are flooded with the Schiff's reagent, he azo-coupling reagent, or any of the dyes listed. The rapid methods tabulated above have the comnon advantage that, with the short time allowed or diffusion of penicillin, the reference curve obtained y plotting log diameter against log concentration s linear over a useful range more than twice that of he present standard method.

This work was carried out with the laboratory ssistance of Toinie Juntunen, and was made possible y a generous research grant from the Cutter Laboratories, Berkeley, California.

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Feb. 20.

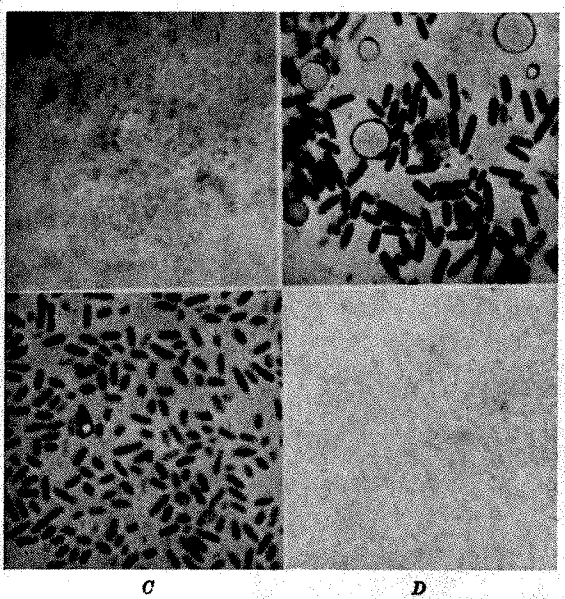
Schmidt, W. H., and Moyer, A. J., *J. Bact.*, **47**, 199 (1944).
Dufrenoy, J., and Pratt, R., in the press.
Goyan, F. M., Dufrenoy, J., Strait, L. A., and Pratt, R., *J. Amer. Pharm. Assoc.*, Sci. Ed., in the press.

Nucleotide Metabolism of Bacteria and the Bacterial Nucleus

OWING to the content of purine and pyrimidine ings of the nucleic acids, they exhibit a specific bsorption within the ultra-violet range with an bsorption maximum at 2600 A. This makes it ossible to demonstrate directly the presence of ucleotides in cells. The quantitative conditions can e studied by means of the technique devised by Caspersson and co-workers. A method has now been vorked out in which the order of magnitude of the ucleotide content in bacteria can be determined by hotometry of microphotographs taken at 2570 A.

Both Gram-negative and Gram-positive bacteria ave been investigated (*Escherichia coli, Aerobacter erogenes, Proteus vulgaris, Flavobacterium, Bacillus ereus, Staphylococcus albus, Streptococcus fœcalis, Spirillum rubrum* and *Corynebacterium diphtheriæ*), nd a series of investigations was carried out for ach type of bacterium; about forty organisms vere used.

In all cases great changes took place in the nucleotide content during the early phase of growth, the ucleotide content reaching a maximum during the nd of the lag phase or the beginning of the logarithmic hase. The nucleotides of the individual bacterium nderwent an increase corresponding to five to ten imes the original content. A general conception of he variations is obtained from the accompanying eproduction, which shows the content of absorbing ubstance in *E. coli* on four different occasions. The ontrast obtained in the positive is a relative measure f the nucleotide concentration.



PHOTOGRAPHS OF *E. coli* TAKEN AT 2570 A. *A*, INOCULUM; *B*, MIDDLE OF LAG PHASE; *C*, BEGINNING OF LOGARITHMIC PHASE; *D*, PHASE OF DECLINATION

In the case of *E. coli*, where a nitrogen analysis was made in one experiment, it was found that, on the whole, the total amount of nucleic acid and protein followed the same course. Further, it appears that there was a connexion between the length of the generation time and the nucleotide metabolism. The amount of nucleic acid newly formed during the generation was in inverse relation to the generation time. However, this did not hold good for the first generation, during which the new formation was especially pronounced. The divergence for this generation and the lag phase included in it may be interpreted as an expression of a diffusion or a secretion of protein, the formation of which has been shown to presuppose the presence of nucleotides (Caspersson).

The increase in nucleotides and in the volume of the individual bacterium occurred during the same period. The volume variations were especially pronounced for *B. proteus*, in which the increase in volume and nucleotide content ran parallel and were in inverse relation to the size of the inoculum. The increase in size could be ascribed mainly to an uptake of water.

The observations made by ultra-violet microspectrography and Feulgen–Rossenbeck's nuclear reaction indicated that the bacteria have two nucleotide systems connected with bacterial growth, one of ribose and the other of ribodesose type. In common with a number of other research workers, we were able to prove the presence of Feulgen-positive structures which evidently undergo fission in connexion with bacterial fission. The formation of ribose nucleotides appears to start from ultra-violet-absorbing grains, which in connexion with the intense increase of nucleotide disappeared in the diffusely absorbing bacteria. We consider that we have gained support for the assumption that bacteria have a nuclear mechanism the function of which agrees in principle with that met with in metazoan cells. The two systems form a functional unit, but are not combined in a morphological unit. The ribodesose organella which undergoes fission would form an equivalent to the euchromatin of the metazoan cell; the ribose system would be looked upon as a functional counterpart to the heterochromatin. From the former the formation of gene protein is induced; the latter controls the formation of the protein of the cell body. This latter process is reflected in great changes in the content of ribose nucleotides in the individual bacterium.

A detailed account of this work will be published shortly.

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Feb. 28.

Cytochemical Effects of Œstradiol

The œstrogenic action of certain carcinogenic hydrocarbons such as 3:4 benzpyrene and 5:6 cyclopentane-1:2 benzanthracene and the carcinogenic effect of œstrogenic hormones (see recent review by Greenstein[1]) suggested to us a comparison of the cytochemical effects of œstradiol on the vaginal wall of mice with the primary effects of methylcholanthrene on the epidermis studied in detail by Cowdry and his collaborators.

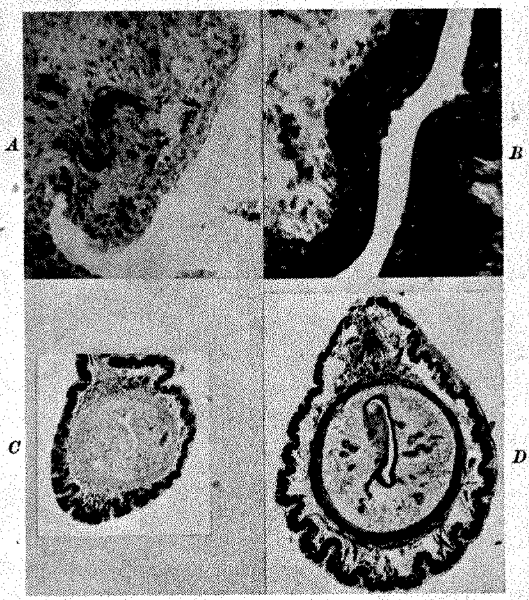
As early as 24 hours after the injection of 10 mgm. œstradiol into a mouse, ovariectomized one month previously, the proliferating vaginal wall shows a very marked increase in alkaline phosphatase activity, especially in the cytoplasm of the cells (technique of Gomöri[2]). This observation was confirmed by *in vitro* determinations of phosphatase activity in vaginal extracts, which show that orthophosphate liberated in three hours from sodium glycerophosphate increases, for example, from 430 γ to 1,500 γ P per mgm. protein nitrogen. This increase in alkaline phosphatase activity is accompanied by a large increase in cytoplasmic ribonucleic acid detected by the ribonuclease technique of Brachet and confirmed by estimations following Schneider's technique[3].

These two phenomena are comparable to those which have been found to occur in mouse epidermis after methylcholanthrene treatment (Biesele[4]).

An increase in alkaline phosphatase activity of the same order of magnitude is shown in the uterus, principally in the circular muscle layer[5]. In this organ, also, there is a parallel increase in the concentration of ribonucleic acid. One can observe regularly a slight increase in alkaline phosphatase activity in the liver, but no increase in brain, kidney or blood plasma.

Brachet and Jeener[6] have put forward the hypothesis that the increase in phosphatase activity observed in the nuclei of regenerating liver may be related to the increase in thymonucleic acid phosphorus turnover. A similar hypothesis does not seem to be applicable to variation in cytoplasmic phosphatase activity. For example, the ribonucleic acid metabolism in pancreas must be very high (Caspersson[7]), notwithstanding the fact that phosphatase content of this organ is very low.

On the other hand, the data given in this report are in agreement with the idea that an increase in alkaline phosphatase is not parallel to general protein synthesis, but only to the synthesis of fibrous proteins (see review by Moog[8]). Keratin is rapidly synthesized by the vaginal wall under the influence of œstradiol. Some preliminary data lead us to believe that myosin synthesis occurs in the uterus unde the same conditions. The absence of any increase o phosphatase activity in the crop of the prolactin-injected pigeon can well be explained by the absence of any histological signs of keratin or collagen fibre synthesis during the growth of its mucosa. Finally, we note the similarity between effects of œstradiol on vaginal and uterine phosphatase and those o androgen hormones on the prostate (Gutman[9]).



A and *C*, vaginal epithelium and uterus of a castrated mouse; *B* and *D*, same tissues 24 hours after injection of 10 γ œstradiol. Sections treated simultaneously by Gomöri's technique

R. Jeener

Department of Animal Physiology,
University of Brussels. Feb. 22.

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[2] Gomöri, G., *Proc. Soc. Exp. Biol. N.Y.*, **42**, 23 (1939).
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Synthesis of Methionine and Similar Amino-Acids

Of several recent syntheses of *dl*-methionine, tha commencing with γ-butyrolactone[1] is relatively long while others[2] are additionally inconvenient in tha they employ methyl-β-chloroethylsulphide, a vesican intermediate. It seems, therefore, desirable to stat that the following series of reactions has been foun to afford an overall yield of *dl*-methionine of 29 pe cent (that is, based on acrolein), and to be free fro disadvantages such as those mentioned above:

$$CH_2:CH.CHO \xrightarrow{MeSH} CH_2(SMe).CH_2.CHO \xrightarrow{HCN}$$

$$CH_2(SMe).CH_2.CH(OH)CN \xrightarrow{NH_3/EtOH}$$

$$CH_2(SMe).CH_2.CH(NH_2)CN \xrightarrow[\text{at } 100^\circ]{\text{Conc. HCl}} dl\text{-methionine}$$

Commercial acrolein containing a trace of tri ethylamine was treated with methylthiol to giv β-methylthiopropionaldehyde, which, after isolation, was allowed to react with liquid hydrogen cyanide in presence of a small amount of potassium cyanide. The crude cyanohydrin was converted at 80° into the corresponding aminonitrile, which was isolated as its oxalate and hydrolysed to methionine. It may be recalled that β-methylthiopropionaldehyde has previously been obtained from acrolein[3], though apparently only under obscure conditions or in small yield. Moreover, the methylthioaldehyde has been converted by what are in principle the steps outlined above into *dl*-methionine[4], but low yields seem to have given the premature impression that this synthesis is of little practical value.

In the present work similar reactions have also been used to prepare analogous acids such as ethionine, α-amino-γ-benzylthio-*n*-valeric acid, and α-amino-γ-benzylthio-γ-methyl-*n*-valeric acid in satisfactory yield. The last-mentioned compound has been debenzylated to give α-amino-γ-thio-1-γ-methyl-*n*-valeric acid, an analogue of penicillamine, the degradation product of the various penicillins.

A full account of these syntheses has been submitted for publication in the *Journal of the Chemical Society*.

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Origin of Erythrocytes

It seems desirable to utter a caveat in reference o Dr. S. H. Wajda's communication on the origin of erythrocytes from striated muscle[1]. During he last two years, many hundreds of sections of muscles previously traumatized by various means have been studied in great detail in this Department. In view of the suggestion often made in he past (and particularly in view of the recent work of Chèvremont) special search has been made for convincing evidence of the transformation f muscle fibres into various types of connective tissue cells. Unfortunately, the histological picture is usually extremely confused in the traumatized rea at first and, unless the sections are studied with critical eye, it is possible to mistake histiocytic and ther phagocytic elements for actual transitional forms between disintegrating muscle cells and various connective tissue cells. Because of these difficulties, it has been reluctantly concluded that this type of material is really not adequate for the solution of such a problem. In some cases it can be ertainly demonstrated that the appearance seen under the microscope suggesting a transformation of a muscle fibre into histiocytes is quite illusory although, of course, this does not preclude such a possibility).

It seems not improbable that the suggested transformation of striated muscle fibres into red blood corpuscles (a process which is referred to by Dr. Wajda as 'instantaneous') is also based on such illusory appearances. One of the members of this Department has been engaged for several months in the study of living striated muscle fibres by micro-dissection, and has often watched them *in vivo* for several hours after traumatization. In no case has any process been observed which is even remotely similar to that described by Dr. Wajda.

W. E. Le Gros Clark

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[1] *Nature*, **159**, 254 (1947).

The working hypothesis on blood formation on which Prof. Le Gros Clark comments was put forward because the wealth of observation behind it could not fit any established views on hæmopoiesis, and because some general statement was warranted, if for no other reason, as a basis for further experiment. My views are based both on extensive cytological observation and on experimental evidence which will be fully discussed elsewhere.

I do not agree that the histological picture of traumatized muscle is so confused as to defy critical examination. The architecture of striated muscle is much more regular than that of loose connective tissue, a tissue of choice in the study of inflammation, and a cytologist should not encounter any great difficulty in following its cellular changes.

Judging from his own published work on muscle, Prof. Le Gros Clark's studies have been neither concerned with muscles working at the time of fixation, nor with acute changes in them, nor, indeed, with blood formation. This might, in part, account for his failure to confirm my observations. At the same time, I might direct attention to the fact that there is a photomicrograph (Fig. 23) in his latest paper which clearly shows cells budding off from an injured muscle fibre, and the process itself is described in some detail in the text. Prof. Le Gros Clark decided, however, that the fate of these new elements could not be determined.

It is necessary for me to emphasize again that the instantaneous discoidal disintegration of muscle fibres had been described long before I was able to confirm its occurrence. It has also been recently observed *in vivo*, and recorded cine-photomicrographically by Speidel as a "progressive transformation of single sarcomeres into discrete thin clots". As Speidel points out: "a few seconds of electrical stimulation were sufficient to initiate the formation of an incipient clot". It should not, therefore, be impossible to check Thoma's statement that disintegration may begin "plötzlich in beinahe explosionsartiger Weise" by repeating both his and Speidel's experiments.

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Internal Waves and Upwelling of Oceanic Water from Mid-depths on to a Continental Shelf

In January 1947 at a time when the winter maximum for inorganic phosphate dissolved in the sea is usually reached, a series of observations was made in the western English Channel. In an area north of the coast of Brittany in water of $35{\cdot}40$–$35{\cdot}45\,{}^0/_{00}$ salinity, temperature about 1° C. higher than in the surrounding water and a zooplankton community typical of 'south-western' water[1], phosphate around $0{\cdot}40$ mgm.-atom/m.^{3} P was found. If, as appears probable, this is typical of Atlantic surface water at midwinter, the 'Channel' (setosa)[1] water, characterized by the presence of the chætognath, *Sagitta setosa*, which has occupied the English Channel in the neighbourhood of Plymouth since 1930–31 and has similar maximum phosphate content (0·42–0·48 mgm.-atom/m.^{3} P), may well have been derived from it. We should, however, have to look elsewhere for the origin of the higher phosphate content (0·6–0·7 mgm.-atom) of the 'elegans' or 'western' water[1] of the Celtic Sea, which in the nineteen twenties also filled the western end of the English Channel. The most probable source is upwelling of deeper ocean water from the continental slope. Such upwelling may be attributed to off-shore winds, which would need to be from the north and east. South-westerlies are the prevailing winds of the area both in direction and strength, and the winds from the northern and eastern sectors would, in general, seem not to blow hard enough or long enough to produce upwelling on the scale required. Periods of prolonged fresh easterly winds such as February 1947 are rather exceptional.

There is another possible mechanism by which nutrients could be brought from the deeper waters on to the continental shelf. The existence of internal or boundary waves in the ocean with an amplitude up to 100 metres is now well established. If such waves should impinge at right angles to a vertical cliff, no doubt they would be totally reflected. The continental slope, though steep, is far from vertical, so that the energy of an impinging wave must be dissipated in some other way. Most probably such a wave would run up the slope much as a surface wave runs up a shelving beach. In this way nutrient-richer water at mid-depths could be brought higher on to the shelf, where normal vertical mixing due to wind-waves and surface winter cooling would complete the process of bringing the richer water to the surface.

No evidence has yet been adduced to show whether or not submarine valleys or canyons such as those found on the New England coast are present along the continental slope west of the English Channel. If such exist, they would concentrate the energy of the internal wave into a contracting cross-section and greatly amplify the power of an internal wave to project deeper water into the surface layers. For a full understanding of the fertility of the sea in this area, a synoptic survey of the internal waves in the Atlantic abreast of the slope and a knowledge of the topography of the slope itself is therefore called for.

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March 5.

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[1] Russell, F. S., *Cons. Perm. Int. Expl. Mer, Rapp. Proc.-verb.*, **100**, 7 (1936); *J. Mar. Biol. Assoc.*, **20**, 309 (1935).

Relative Directions of the Electric and Magnetic Vectors in Electromagnetic Waves *in vacuo*

Are the electric vector ($\vec{E}$) and the magnetic vector ($\vec{B}$) in electromagnetic waves *in vacuo* always mutually perpendicular, or are they not always so?

I put this question to a number of distinguished physicists, and all of them, without exception, answered definitely in the affirmative at first—and then agreed with me that the correct answer should be in the negative.

It follows from the Maxwell equations

$$\dot{\vec{E}} = c \operatorname{curl} \vec{B} \qquad \dot{\vec{B}} = -c \operatorname{curl} \vec{E}$$

that the time derivative vector of $\vec{E}$—not the vector itself—is perpendicular to $\vec{B}$ and, correspondingly, the time derivative vector of $\vec{B}$—not the vector itself—is perpendicular to $\vec{E}$. But the directions of the vector and of its time derivative always coincide only in the case of a non-rotating vector. This is, however, as a rule, not so in the case of a rotating vector (take, for example, the acceleration and the velocity in curvilinear motion).

Thus, in plane polarized plane electromagnetic waves, where the vectors $\vec{E}$ and $\vec{B}$ do not rotate, they are mutually perpendicular; but in rotating electromagnetic waves[1] and in electromagnetic whirls[2], where these vectors rotate, they are, generally speaking, *not* mutually perpendicular. Only in some exceptional cases are $\vec{E}$ and $\vec{B}$ perpendicular, in spite of rotation. This happens, for example, in circularly polarized plane waves, where both vectors are coplanar and rotate with equal angular velocity always at right angles to each other; and in spherical or in cylindrical waves, where one of the vectors rotates in an axial plane, while the other vector remains in the same position in an angular plane[1,2,3].

Apparently this point is usually overlooked, because until quite recently very little attention was given to the study of electromagnetic waves with rotating vectors other than plane and spherical waves

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Feb. 15.

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[1] *Phil. Mag.*, **19**, 934 (1935).

[2] *Phil. Mag.*, **20**, 417 (1935).

[3] *Nature*, **137**, 582 and 1031 (1936).

Origin of Solar 'Static'

Recently, Martyn[1] wrote: "It is natural first to seek an explanation [of the origin of solar static] in terms of the kind of electrical discharge which cause the familiar terrestrial radio noise, namely, lightning flashes; but it is difficult, if not impossible, to se how such discharges could be produced in the alway highly ionized solar envelope". The explanation to which Martyn raises objection is, in fact, one which I have myself put forward recently[2]. His objection however, does not arise on the general theory which I have advanced elsewhere[3]. Far from preventing the existence of electric fields at the sun's surface the thermal conditions there are themselves the result of electrical discharges. These discharges occur i the radial electric field set up by the emission o highly charged atoms from nuclear reactions in th sun's interior.

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Feb. 26.

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[1] Martyn, D. F., *Nature*, **159**, 27 (1947).

[2] Bruce, C. E. R., *Observatory*, **66**, 263 (1946).

[3] Bruce, C. E. R., "A New Approach in Astrophysics and Cosmogony (London, 1944).

CHEMISTRY OF THE PROTEINS

A DISCUSSION meeting on the "Chemistry of the Proteins" was held by the Chemical Society in the University of Bristol on February 13. Prof. J. L. Simonsen was in the chair, in the absence, through illness, of the president, Prof. C. N. Hinshelwood. The following papers were submitted: (1) "The Integration of Physical Methods in the Elucidation of Protein Structure", by Prof. J. D. Bernal; (2) "Modern Methods of Amino-Acid Analysis", by Dr. G. R. Tristram; (3) "The Degradation of Proteins by Proteolytic Enzymes", by Dr. J. A. V. Butler; (4) "Some Physico-Chemical Aspects of Plasma Proteins", by Dr. R. A. Kekwick.

Prof. Bernal outlined the physical methods by which information on the size, shape and crystal structure of the intact protein may be obtained. The ultra-centrifuge, with which Svedberg made the first great advance in the investigation of the gross structure of proteins, has now been shown to have certain fundamental limitations. As a method of estimating absolute molecular weights, it has probably an accuracy of 20 per cent, but it still provides accurate comparative data in investigations involving the fractionation of proteins. The electrophoresis technique introduced by Tisélius is also of great value in comparative studies, but it can do no more than separate out the different groups of proteins. Information on the shape of the protein particle has been obtained by sedimentation, viscosity and anomalous viscosity measurements and flow birefringence.

In reviewing the whole field Prof. Bernal stated that X-rays provide the most accurate means of investigating the gross architecture of the protein crystals. Perutz and Crowfoot have demonstrated how X-ray technique may best be applied, and their work has provided much information on the crystal structure of hæmoglobin and insulin respectively. The usefulness of the technique would be extended when it became possible to carry out measurements on the protein crystal in solution.

The electron microscope is a new instrument, now in the process of development; its resolving power is now about 10 A., and in the near future a resolving power of 5 A. may be expected. Already many remarkable results have been obtained, and the instrument may prove to be one of the most powerful means of examining the structure of proteins.

In conclusion, Prof. Bernal suggested that the time has now come when the efforts of the various branches of protein research should be co-ordinated.

Dr. G. R. Tristram next outlined the means which are now available for the investigation of the amino-acid composition of proteins. Prior to 1939, most of the methods were gravimetric, required upwards of 10 gm. of protein for each analysis and yielded results upon which little reliance could be placed. In recent years, there has been a rapid development of methods, based upon many novel principles, which require very small amounts (10–100 mgm.) of protein. Among the more important of these methods are: electrodialysis for the estimation of the basic amino-acids; partition chromatography for the estimation of certain of the mono-amino-acids; specific decarboxylases; isotope dilution and microbiological assay. Microbiological assay, which has undergone tremendous development in the United States, and isotope dilution are capable of application to the whole range of amino-acids, although it is impossible to assess their real value because much of the work on the microbiological technique has been uncritical, and so far isotope dilution has not been widely used.

The assessment of the accuracy of any method of analysis is handicapped by the impossibility of carrying out *bona fide* control experiments. It is therefore suggested that each method should (i) be capable of giving reproducible recoveries when tested on *ad hoc* mixtures of amino-acids; (ii) that the values obtained should be reproducible; and (iii) should be capable of duplication by independent methods.

A special technique has recently been developed by Sanger which makes it possible to characterize and estimate the amino-acids which provide the terminal NH_2 group(s) of the inact protein. Using this technique, much interesting information has been obtained by Sanger and his co-workers.

Insulin has now been analysed by Chibnall and his co-workers, and their chemical data suggest that the 'submolecule' has a molecular weight of about 12,000 and contains about 106 residues (102 of which have been characterized by analysis). The work of Sanger reveals that each 'submolecule' has four chains, the terminal amino-groups of which are two residues each of glycine and phenylalanine.

The development and uses of paper chromatography were outlined by Dr. A. H. Gordon. This qualitative technique makes possible the micro-detection and characterization of amino-acids and peptides. It has been used by Martin and Synge and their co-workers in their work on the structure of gramicidin-S.

Dr. J. A. V. Butler suggested that another method of approach to the determination of protein structure is by partial enzymatic hydrolysis. The products of hydrolysis should have molecular weights of about 1,000. Experiments have been carried out on the action of chymotrypsin and pepsin on insulin. The initial action of chymotrypsin is to hydrolyse off about eight peptide fractions, molecular weight *c.* 700, leaving a fairly massive core having a mean molecular weight of about 5,000. The latter is still precipitable by trichloracetic acid and is therefore easily separated. It contains the greater part of the cystine. Pepsin, on the other hand, breaks the molecule into fragments having a mean molecular weight of about 3,000.

It was observed many years ago that when peptic digests of insulin and other proteins are concentrated and treated with more pepsin at *p*H4, substances, insoluble in trichloracetic acid, the so-called 'plasteins', are formed. This was thought to be due to a resynthesis of peptide bonds. It has now been found that insoluble material is formed when peptic digests are incubated at various hydrogen ion concentrations, even when pepsin has been inactivated. It is suggested that some of the original peptic fragments still retain much of the order of the original protein and, when heated and treated in other ways, undergo changes similar to those which occur in protein denaturation, giving rise to an insoluble product.

Dr. R. A. Kekwick outlined methods of protein preparation with special reference to the plasma proteins. Although it is possible to isolate proteins by electrophoresis, the amounts obtained are necessarily limited. The method is of great value, however, for the control of fractionation procedures.

The solubility of a protein in aqueous solution depends upon pH, salt concentration, temperature and total protein concentration. Cohn studied the fractionation of plasma proteins with ethanol and established that, provided the temperature is maintained between 0° and $-10°$ C., a further variable, the reduction of protein solubility by means of solvents, may be introduced with great advantage.

In the past, the application of electrophoresis and the ultra-centrifuge have been the main criteria for the purity of protein preparations. As Prof. Bernal pointed out, these methods are not adequate for the assessment of absolute purity. It is now generally agreed that the final test for purity of any protein should be the estimation of solubility, that is, the solubility should be independent of the amount of protein present in the solid phase.

THE MATHEMATICAL ASSOCIATION

ANNUAL MEETING

A GENERAL meeting of the Mathematical Association was held at the Polytechnic, Regent Street, W.1, during April 9 and 10, under the presidency of Mr. W. F. Bushell, head-master of Birkenhead School.

Mr. Bushell covered a wide field in his presidential address, "A Century of School Mathematics", giving a comprehensive and detailed account of the changes which have revolutionized the teaching of school mathematics in England during this period. The general level of mathematical teaching in mid-Victorian times was described by means of much instructive and entertaining material drawn from the two famous inquiries commonly known as the Clarendon Commission and the Endowed Schools Commission. By 1871, the sterility of a dull routine of a little arithmetic, algebra and Euclid, with no attempt to relate these topics to everyday life, was generally recognized by teachers; but the Association for the Reform of Geometrical Teaching (now the Mathematical Association), founded by Levett (King Edward School, Birmingham) and J. M. Wilson (then of Rugby, later head-master of Clifton and canon of Worcester), struggled for many years with the inertia of the older universities, the influence of which on the school curriculum through examinations was preponderating. The work of the Association did not begin to show real fruit until the early years of the present century; but since then, steady progress has been made towards an understanding of the proper place of mathematics in the schools and towards a mode of teaching which shall recognize the dual aspect of mathematics, as a high exercise in abstract thinking, and as a basic human element in the life of the ordinary citizen. Mr. Bushell noted that turning-points in the teaching of mathematics had occurred simultaneously with wars and crises in world affairs, the foundation of the Association for the Reform of Geometrical Teaching in 1871, the Balfour Act of 1903, and the Fisher Act of 1917; and he drew from this the hope that the Butler Act of 1944 would afford teachers of mathematics an opportunity for still further reforming progress.

During the afternoon of April 9, a demonstration and discussion on "The Place of Visual Aids in the Teaching of Mathematics" was held. Mr. I. R. Vesselo showed a number of films and film strips, suggesting possible uses for such visual aids in ordinary class teaching, and Mr. G. Patrick Meredith described a general theory of 'graphics' underlying the use of such material. The discussion seemed to show that the majority of teachers are not convinced that the film material as yet available in mathematics is sufficiently helpful to allow it to replace blackboard and chalk. In connexion with the discussion, Mr. Vesselo had arranged a very comprehensive exhibition of visual aids, which was open during the two days of the meeting. Models, wall charts, pictures, diagrams, all bearing on the teaching of school mathematics, had been collected in large numbers, and showed how much can be done with simple and inexpensive materials.

Later, Prof. H. Davenport (University College, London) gave a paper on "The Geometry of Numbers", in which he described in extremely lucid and simple fashion the way in which Diophantine problems in the theory of numbers can be solved by the application of geometrical concepts, a method due in the first place to Minkowski, and since then used and developed by many workers in this field.

The proceedings on April 10 opened with a paper from Mr. B. C. Brookes (Bedford) on "The Incorporation of Statistics into a School Course". The general opinion of teachers is in favour of such incorporation; but there are difficulties which have often proved insuperable, due, for example, to the influence of external examinations on the school curriculum. Mr. Brookes dealt with the place of statistics in a 'sixth form' curriculum and also in the general mathematical course in a school, and paid attention to the necessary detail of content, method and balance between theory and application. Members were much impressed by the sound practical suggestions put forward in this paper.

Dr. R. L. Goodstein (University of Reading) spoke on "Proof by *reductio ad absurdum*". He analysed the formal logic underlying such proofs, showing how they depend essentially on the logical 'law of contradiction' and 'law of the excluded middle', and by means of an example exhibited the difficulties and paradoxes which may arise. Again, by means of three simple examples he showed that a direct proof may often be not only as simple as an indirect proof, but may in general be expected to yield more precise information. He referred briefly to recent work on logic by Post and Lukasiewicz, in which many-valued logica systems are elaborated; in such systems the two values 'true' and 'false' of a proposition are replaced by three or more.

A discussion took place on April 10 on "A Unified Course in Mathematics in Secondary Schools", being in some sense a sequel to last year's discussion on mathematics in the 'modern' school. The discussion was opened by Mr. A. W. Riley (Wolverhampton), Mr. K. S. Snell (Harrow) and Miss E. Barnes (Birmingham). All three of the opening speakers stressed the need for seeing the school course in mathematics from the point of view of the child, rather than considering it as a mental discipline imposed on the child from above. All agreed that in the early stages the child's knowledge must grow out of his (or her own needs and increasing awareness of the externa world. For this purpose, mathematics should b presented not as a set of disconnected water-tight compartments labelled 'arithmetic', 'algebra', etc. but as a growing body of knowledge which will b rithmetical, algebraical, geometrical or trigonometrical in turn as occasion demands. The growth f such knowledge was compared to that of a tree, vith a main trunk from which in due time various ranches will spring, not all at the same time, nor ll growing at the same rate. Mr. Riley discussed he whole field, and made specific suggestions for the etails of a unified course ; Mr. Snell dealt with the arlier part of the secondary course, and Miss Barnes vith the later part, referring specially to her own vork in a girls' school. In the open discussion, Mr. . V. Durell stressed the importance of equipping the hild with the mathematical tools which he will need or life in the modern world, and the equal importance f training the child to select the mathematical tool ppropriate to a particular task. The discussion was igorous and keen ; the need for suitable text-books vas mentioned, but many members agreed with Mr. R. L. Parsons (Merchant Taylors') in his insistence hat if a clear objective is, first and foremost, envisaged by the child, and then by the teacher, the ext-book problem is but a small matter.

The final paper of the meeting was by Mr. P. F. Burns, on "Astronomy in the Schools". Mr. Burns poke as an enthusiast, but he wasted no time on bstract arguments ; he went straight to the point y showing how much can be done with children hose mathematical knowledge is very small. On he minimum—a surprisingly small one—of such nowledge, he showed how children in two schools n the same meridian, one in Lancashire and one in loucestershire, had made and combined observations o as to be able to deduce the length of the circumference of the earth. By ingenious cutting and olding of simple diagrams, with a little elementary eometrical drawing, he showed a method for determining the great circle distance between two points n the earth's surface.

The president of the Association for the forthcoming year is Prof. G. B. Jeffery, principal of the nstitute of Education, University of London.

THE BEGINNING OR THE END? "

THE much-heralded film "The Beginning or the End ?" (Metro-Goldwyn-Mayer) was shown privately to a distinguished audience in the Palace heatre, London, on April 22. Judged by any andard or from any point of view, it is not a good m. Generally, it is dull—a cardinal sin in a film eant for the commercial cinema. From the documentary point of view it is disappointing, since it ally tells so little about all the atomic research hich led eventually to the release of atomic energy ; fact, it confines itself solely to that comparatively hort time devoted to the development of the atomic omb in the United States. This will assuredly lead he non-scientists into believing that most atomic nergy research has been American. Apart from three ss well-known British atomic scientists who, according to the film, represented the British contribution dered to America by Mr. Winston Churchill, the haracters are all American. (It is stated that Fermi orked in his native Italy until 1939.)

Towards the beginning of the film, lip-service was aid to the contributions of such geniuses as Rutherford, Joliot, Chadwick, Hahn and a few others, in ne or two sentences uttered from his arm-chair by n actor representing Einstein, but whose elocution as so poor that even this small concession will be lost on a lay audience. Meitner, Oliphant, Blackett, Cockcroft, Bohr and other important persons were not mentioned at all. On the other hand, Oppenheimer, Fermi, Vannevar Bush, Urey, Conant, Szilard, Compton and Lawrence were all represented in the plot, though, with the exception of Fermi and Szilard, none figured very largely.

It is true that the film confined itself to the development of the atomic bomb, and we know that most of that work took place in the United States. In view of this, it would have been better if the entire film had been produced as a documentary. But if the world is to realize the importance of atomic energy research and its effect for good or ill on man and his future it would have been best not to lift this section of an almost world-wide and long-drawn-out team work from its context. A more faithful, comprehensive and revealing study of the science of the atom is necessary if the commercial cinema is to continue its excellent contributions to adult education, to which we have frequently referred. Perhaps in due course, Metro-Goldwyn-Mayer or the J. Arthur Rank Organisation will consider presenting to the public the whole romance of atomic research, going back even as far as Dalton and reaching as a climax not only the release of atomic energy in the form of a bomb but also a few prophetic shots of what atomic energy could do for power production, medical research, etc. Then we may be sure that such scientific worthies as Thomson, Curie and Rutherford will be revealed as important contributors to what is really one project.

A 'brains trust' followed the showing of the film—not to discuss and criticize the film but to answer questions of human interest in connexion with atomic energy. Its personnel comprised Royal Air Force and Royal Navy observers at the actual bomb explosions, two politicians, an actor and author and Dr. C. E. M. Joad. It will be noted that science itself was not represented on this 'trust' in spite of the fact that the omission was pointed out to the organisers in plenty of time for it to be rectified. This is to be deplored, especially in view of the fact that several atomic physicists of international fame are within comparatively easy reach. It is to be hoped that we may not look upon this choice as indicative of the attitude of the intelligent public to present-day science.

One important function this film might have is to bring home to every man and woman who sees it a deeper sense of urgency which seems to be lacking, especially in Britain. A copy of the film was buried with due solemnity beneath the giant redwoods of California, to be disinterred five hundred years hence. If anyone exists then, we doubt whether he will learn anything that he has not already learned from more authoritative sources, especially the publications of the men of science themselves.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 28

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5 p.m.—Scientific Papers.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at Faraday Building, 9th Floor, South Block, Knightrider Street, London, E.C.4), at 5 p.m.—Mr. K. W. Hix : "Repeater Station Power Supplies".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Domestic Water Heating by Electricity" (to be opened by Mr. R. Grierson and Mr. Forbes Jackson).

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester).—Annual General Meeting.

Tuesday, April 29

University College (at Gower Street, London, W.C.2), at 5.15 p.m.—Dr. M. H. Pirenne: "The Quantum Physics of Vision" (other lectures on May 6 and 13).*

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Prof. F. E. Zeuner: "Climate and Early Man in East Africa".

Royal Photographic Society, Scientific and Technical Group (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. E. E. Loening: "The Latent Image in the Test Tube".

Sheffield Metallurgical Association (at 198 West Street, Sheffield), at 7 p.m.—Mr. Brinley Jones: "Springs for High Duty Purposes".

Society of Instrument Technology (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. A. Hall: "Molten Metal Temperature Measurement".

Wednesday, April 30

Botanical Society and Exchange Club of the British Isles (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting.

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Mr. E. J. B. Lloyd: "Economic Reconstruction, 7, Distribution".

Challenger Society (at the Zoological Society, Regent's Park, London, N.W.8), at 5.45 p.m.—Dr. Anton Fr. Bruun: "The *Atlantide* Expedition to the West African Coast".

Institute of Welding (joint meeting with the Institute of Metals, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. Maurice Cook and Mr. Edwin Davis: "The Welding of Copper and the Copper-Rich Alloys".

Thursday, May 1

Institution of Mechanical Engineers, Graduates' Section (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Annual General Meeting. Mr. E. A. Ritchie: "Statistical Quality Control".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, May 2

Chemical Society, Exeter Branch (in the Washington Singer Laboratories, The University, Bristol), at 4.30 p.m.—Prof. M. Stacey: "Advances in Immunochemistry".

Society of Public Analysts and other Analytical Chemists, Physical Methods Group (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 p.m.—Papers on "Physical Methods of Gas Analysis".

Society of Dyers and Colourists (at the Royal Technical College, Glasgow), at 7.30 p.m.—Mr. E. J. Bowen, F.R.S.: "Colour and Constitution—Absorption of Light by Chemical Compounds" (Fourth Mercer Lecture).*

Saturday, May 3

British Interplanetary Society (at St. Martin's Technical School, Charing Cross Road, London, W.C.2), at 6 p.m.—Mr. M. W. Ovenden: "The Nature and Distribution of Meteors".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Graduate Assistant Teacher of Mechanical Engineering Subjects—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middx. (May 3).

Teacher of Mechanical Engineering Subjects—The Principal, Acton Technical College, High Street, Acton, London, W.3 (May 3).

Lecturer in the Department of Chemistry and Applied Chemistry—The Principal, Royal Technical College, Peel Park, Salford 5 (May 3).

Teacher of Mechanical Engineering Subjects—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (May 3).

Lecturer in Mathematics—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 3).

Assistant Lecturer (well-qualified graduate) to teach Mechanical Engineering up to Higher National Certificate standard, and an Assistant Lecturer to teach General Mechanical Engineering to at least the Ordinary National Certificate, in the York Technical College—The Chief Education Officer, Education Offices, 5 St. Leonard's, York (May 3).

Director of Physical Research in the Admiralty—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1 quoting No. 1853 (May 8).

Scientific Assistant (temporary) in the Department of Zoology for research on fertility in mammals—The Secretary and Registrar, University College of North Wales, Bangor (May 8).

Lecturer in Geophysics—The Professor of Physics, Imperial College of Science and Technology, South Kensington, London, S.W.7 (May 10).

Research Officer (Fuel Chemist), Division of Aeronautics, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 967 (May 12).

Senior Research Officer or Research Officer (male), Timber Mechanics Section, Division of Forest Products, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 999 (May 12).

Research Officer (Theoretical Physics), Division of Industria Chemistry, Melbourne—The Secretary, Australian Scientific Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1004 (May 12).

Lecturer in Physics (up to B.Sc. Special standard), preferabl with subsidiary mathematics and chemistry, a Senior Assistant in Biochemistry or Biology, a Responsible Lecturer in Mechanica Engineering (up to Final B.Sc. standard), a Lecturer in Mechanical Engineering, and a Senior Assistant in Civil Engineering—The Registrar, Nottingham Technical College, Shakespear Street, Nottingham (May 12).

Senior Research Officer (X-Ray Crystallography), in th Division of Industrial Chemistry, Melbourne—The Secretary Australian Scientific Liaison Office, Australia House, Strand, London W.C.2, quoting No. 1229 (May 12).

Research Officer (Wood Chemistry Section), Division of Fores Products, Melbourne—The Secretary, Australian Scientific Liaiso Office, Australia House, Strand, London, W.C.2, quoting No. 123 (May 12).

Chair of Mining, and the Chair of Industrial Relations—Th Registrar, University College, Cathays Park, Cardiff (May 15).

Principal Scientific Officer at the Telecommunications Researc Establishment of the Ministry of Supply at Malvern, Worcs.—Th Secretary, Civil Service Commission, 6 Burlington Gardens, London W.1, quoting No. 1856 (May 15).

Superintendent (Projects and Planning) at the Royal Aircra Establishment of the Ministry of Supply—The Secretary, Civil Servic Commission, 6 Burlington Gardens, London, W.1, quoting No. 185 (May 15).

Lecturers (2) in Physics—The Registrar, The University, Glasgo (May 15).

Nuffield Fellowships (3) for experimental and theoretica research in Nuclear Physics, and Technical Assistants (2) in researc work in Atomic Physics—The Professor of Natural Philosophy, Th University, Glasgow (May 15).

Assistant Lecturer or Lecturer, and a Lecturer or Senio Lecturer, in the Department of Biochemistry—The Registra The University, Sheffield (May 17).

Assistant Keeper (Class II)—The Keeper and Secretary, Londo Museum, St. James's, London, S.W.1 (May 17).

Lecturer or Assistant Lecturer in Civil Engineering, and Lecturer or Assistant Lecturer in Geology—The Secretar King's College, Strand, London, W.C.2 (May 17).

Assistant Lecturer (Grade III) in Psychology, and an Assistan Lecturer (Grade III) in Chemistry—The Secretary and Registra The University, Bristol (May 19).

Lecturer in Physiology—The Registrar, The University, Leeds (May 19).

Assistant Lecturers (2, Grade III) in Mathematics, and a Assistant Lecturer (Grade III) in Chemistry—The Secretary an Registrar, The University, Bristol (May 19).

Readership in Agricultural Economics tenable at the Londo School of Economics and Political Science—The Academic Registra University of London, Senate House, London, W.C.1 (May 22).

Senior Principal Scientific Officer (to take charge of researc and other work on precise engineering measurements) at the Nation Physical Laboratory—The Secretary, Civil Service Commissio 6 Burlington Gardens, London, W.1, quoting No. 1859 (May 22).

Principal Scientific Officer (to take charge of a team of worke on the application of X-ray diffraction, etc., to the study of metal an other crystalline substances) at the National Physical Laboratory-The Secretary, Civil Service Commission, 6 Burlington Garden London, W.1, quoting No. 1860 (May 22).

Chief of the Division of Wool Technology, Geelong, Victo —The Secretary, Australian Scientific Research Liaison Office, Austra House, Strand, London, W.C.2 (May 24).

Lecturer or Senior Lecturer in Electro-Technics—T Registrar, The University, Manchester 13 (May 24).

Chair of Psychology—The Registrar, The University, Sheffie (May 24).

Research Officers (2), Division of Industrial Chemist Melbourne—(*a*, Reference No. 1253), to investigate bacterial car hydrate metabolism in relation to industrial fermentation processe (*b*, Reference No. 1254), to conduct investigations on proteins and t products of their hydrolysis by enzymes—The Secretary, Australi Scientific Research Liaison Office, Australia House, Strand, Lond W.C.2, quoting the appropriate Reference No. (May 26).

Assistant Government Chemist in Hongkong—The Director Recruitment, Colonial Service, 15 Victoria Street, London, S.W (May 26).

Lecturer in Botany (excluding physiology and mycology) in t United College—The Secretary, The University, St. Andre (May 30).

Senior Assistant in the Department of Civil and Mechanic Engineering, a Senior Assistant in the Department of Che istry, and a Lecturer in Chemistry—The Principal, Techni College, Queen Street South, Huddersfield.

Lecturer in Physiology and Zoology—The Registrar, Techni College, Sunderland.

Rector of, and Lectureships in, the Teacher Training Colle Achimota, Gold Coast—The Secretary, Achimota Committee, Ed burgh House, 2 Eaton Gate, London, S.W.1.

Senior Assistant Lecturer in the Department of Mechanic Engineering—The Principal, Borough Polytechnic, Borough Ro London, S.E.1.

Senior Lecturer (Senior Assistant) in Physics—The Princip Sir John Cass Technical Institute, Jewry Street, London, E.C.3.

Head of the Physics Department—The Clerk, Northern Po technic, Holloway, London, N.7.

Senior Chemistry Master (to take Chemistry up to scholars standard)—Headmaster, Loretto School, Musselburgh, Edinburgh

Lecturers (2) in Physiology—The Dean of the Medical Colle St. Bartholomew's Hospital, West Smithfield, London, E.C.1.

Laboratory Assistant with experience of food and/or biochemi analysis—Prof. Robertson, Royal (Dick) Veterinary College, Ed burgh 9.

Indian Science News Association
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NATURE

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DEVELOPMENT OF COLONIAL TERRITORIES

THE many-sidedness and complexity of research in the overseas territories of Great Britain are well illustrated in the five annual reports recently published under the title "Colonial Research", a digest of which appears on p. 614 of this issue; but fears that such research is over-organised or centralized excessively should be dispelled by the whole tenor of these reports. In the report of the Colonial Research Committee, in particular, it is observed that it, and the specialist committees in their particular fields, are not to be regarded as the sole fount and origin of all projects of research, and that it would be unfortunate if their mere existence were in any way to inhibit initiative on the part of other agencies or individuals who may have in mind projects of potential interest or value. On the contrary, the Committee would cordially welcome proposals from any source, and will be glad to consider recommending financial assistance toward their execution. As the Colonial Research Committee rightly points out, the scientific needs of the Colonies are too wide and too complex to be made the preserve of any single organisation of committees, and initiative and interest in these fields cannot be too widespread.

It is in keeping with this, and with the further fact that many of the problems, as these reports well illustrate, are regional in scope, that there is already a marked tendency towards collaboration across not merely Colonial but also national frontiers. Such collaboration is increasingly tending to take place at the technical and scientific level, and this may well prove an important factor in promoting closer political understanding and co-operation. Moreover, a second point made by the Colonial Research Committee in this, its third, annual report is of importance in the same connexion. In many fields the problems to be solved at the present stage themselves require accurate identification and definition before they can be profitably investigated. The Committee is therefore disposed to favour projects which have as their immediate objective the exploration and identification of problems, rather than intensive investigations.

Such background research, which enables the scientific problems of the Colonies to be seen in proportion, and general research plans to be framed with some confidence that emphasis is being placed in accordance with actual needs, is, in the Committee's view, required in much greater measure than in the past. Pilot surveys and preliminary studies of this type are in fact no less suitable for co-operation on a regional basis than those intensive investigations on well-defined problems where the value of international co-operation has been so effectively demonstrated during the last three decades.

While the other reports do not discuss the wider aspects of Colonial research in quite the same way or in general terms, such aspects are clearly being kept in mind, as is shown, for example, by the incidental comment of the Colonial Products Research Council that the promising work of evaluating the medicinal properties of many Colonial vegetable products would be gravely handicapped but for the ready co-operation of the Medical Research Council. Again, the general policy adopted by the Colonial Medical Research Committee of trying to obtain men with the initiative and originality necessary for good research, and encouraging them to choose their own problems and their own methods of approach, is well calculated to stimulate creative work of the standard most desired. The five reports, indeed, suggest that none of the Committees is unmindful of Rutherford's conviction that an academic atmosphere, with complete freedom to follow whatever paths of investigation seem desirable or necessary, is essential for progress in fundamental science.

Whether the Committees will be able to avoid, in present circumstances, what Rutherford regarded as such a grave mistake, namely, the tempting of men with high abilities for academic research into industrial or State laboratories, remains to be seen. Assuredly the most fruitful use of the available scientific man-power of Britain will tax the utmost wisdom of the administrator—be he man of science or layman—during the next decade, and the general attitude of these Research Committees as disclosed in these reports is reassuring. The matter is all the more important as the whole trend of Colonial developments, whether under the influence of the Trusteeship Council of the United Nations, or stimulated by such schemes as the plan for the production of ground-nuts in Tanganyika, Northern Rhodesia and Kenya resulting from an official mission to East Africa (Cmd. 7030. H.M. Stationery Office. February 1947. 1*s*. net), is likely to increase the demand both for research schemes and for scientific men in research and development work.

The high importance of this bold and comprehensive scheme for the development of backward territories must be stressed. Its potentialities for meeting the serious threat of famine which now faces East Africa, and to supply food, other than the fats primarily intended for the outside world, have attracted public attention to an extent which rather overshadows those aspects with which the scientific worker is more directly concerned. Even from the point of view of the difficulty which will be experienced in obtaining the staff and equipment required for success, it is important that the scheme should be carefully studied by men of science themselves. It is estimated, for example, that the permanent operation of the project will require about 750 Europeans, and this figure includes, in addition to unit managers and engineers, such specialists as surveyors, soil conservation experts, medical men and welfare superintendents as well as scientific staff. The project outlines a comprehensive research programme, both in regard to the use of land, and the human problems of nutrition.

The scheme is primarily intended to meet the critical shortage of oils and fats, amounting for Britain alone to an annual deficiency equivalent to one and a half million tons of ground-nuts; and although the present acute phase may have passed in four or five years, expert opinion predicts a continuing world shortage for the next ten to twenty years. The position can only be substantially improved by the most highly mechanized forms of agricultural development, and the scheme proposes to take a total area of 3,210,000 acres of waterless, almost uninhabited, fly-infested country, and convert it by mechanized units of 30,000 acres into a healthy farming region producing by 1950–51 a minimum of 600,000 tons of ground-nuts annually. Of the 107 units, eighty are proposed for Tanganyika Territory, seventeen for Northern Rhodesia and ten for Kenya. All the resources of modern scientific agriculture will be employed, and when the units have been brought into production, the farming operations will need a permanent labour force of 32,100 Africans, while at the peak of operations in 1949 and 1950, some 25,000 Africans will be required for bush-clearing alone.

This gigantic undertaking, with which the Government has already decided to proceed on the general lines recommended by the mission, is one of the most stirring examples of the contribution which science can make to human welfare. Apart from its importance in meeting the world's dietary needs of fats and the African need for subsistence, its economic and social effects are likely to be far-reaching. Local plans for development and welfare will be aided by the mass production of ground-nuts, particularly in regard to the clearing of tsetse-infested bush and the control of sleeping sickness, the establishment of water-supplies, the improvement of communications, and the provision of an economic foundation for social advance.

The latter aspect merits a little more detailed consideration. Reflecting the broader tendencies of modern thought, the project rules out private enterprise as permanent owners or operators. The United Africa Co., which is undertaking the initial work, will be replaced by a public corporation sponsored and financed by the British Government, but, with provision for the project to be taken over ultimately, first by the local Governments and eventually by the African communities themselves. Incidentally, the project paves the way for the eventual institution of the co-operative use of land, and it is this emphasis on the community rather than the transformation from primitive to scientific methods of cultivation that marks the truly revolutionary character of the scheme.

What has been lacking in most of the development and welfare schemes for the Colonial territories under the 1940 Act is evidence that development will proceed fast enough for the Colonies to carry their own burden of social services in the near future. Generally, the Colonies are being encouraged to plan for a higher standard of living before it is clear whether they will be able to maintain it. The danger is most apparent in the West Indies; but the present scheme, which involves a capital expenditure of about £24,000,000 spread over six years, well illustrates what is needed in order to raise standards of living.

The decision of the British Government to accept the financial risks of this scheme removes the main difficulty of securing the greater capital investment needed in the majority of development and welfare schemes, and while the scheme is as financially sound as expert foresight can make it, the reservation that agricultural development on the scale and of the type contemplated in the mission's report has not been attempted hitherto in tropical countries adds to, rather than subtracts from, the credit due to the Colonial Office for its initiative. Moreover, the scheme is only one of several measures taken by the Government. A public utility company has been formed to take over the whole of the electricity supply of Nigeria, and the Cameroons Development Corporation will cultivate 250,000 acres on a communal basis, growing rubber, bananas and oil-palms, while all mineral rights in the Colonies are to be nationalized.

This plan for East and Central Africa is thus an example of the kind of work which the Colonial Office will be called upon to undertake in increasing measure in the scientific and concurrent pursuit of the twin aims of development and welfare. Coming at a time when the Trusteeship Council of the United Nations has commenced its task of ensuring the progressive advancement of the many millions of non-self-governing peoples inhabiting the trustee territories, it indicates that, in the Colonial revolution now proceeding, Great Britain will be in the van of progress, and that neither boldness nor imagination will be lacking from her administration of dependent territories. The dual mandate conception of Lord Lugard has entered on a further phase, and one in which the contribution of science will be of growing importance.

This is brought out specifically in two sections of the report itself. Observing that the opportunity which the project provides for introducing measures for the prevention of disease and for desirable standards of nutrition, the report urges that the possibilities should be brought to the notice of the Medical Research Council and its Human Nutrition Research Unit. Similarly, the Colonial Social Science Research Council may wish to consider the wider implications of the project, while the report envisages the creation, at the outset, of a research section of the undertaking, and in accepting the scheme the Government slightly increased the provision for central administration and research installations. The primary task of the research section in the earlier years will be to conduct research and trials to facilitate the maximum economic production of ground-nuts by the use of liming materials, fertilizers, suitable varieties, methods of soil conservation and rotation, and for the control of disease. This work can be planned in such a way as to provide basic data on problems of soil crops in East Africa, thus aiding research on these problems undertaken in the East African Agricultural Departments and at the Central Research Station for East Africa at Amani.

In later years, work in these fields will be extended to include more fundamental aspects. Studies of the production of other food crops, for example, should be linked with nutritional studies and planning, if the project is to make its fullest contribution to the solution of African problems. Veterinary problems will arise as control of the tsetse fly makes possible the introduction of animal husbandry, while, as social and economic research and planning become important, the investigation of natural resources and power supplies for industrial development would follow.

The scientific programme contemplated for the first two years includes meteorology, soil fertility studies, soil survey and mapping, crop disease survey and variety testing. A central meteorological station will be required at each main centre, and appointment of an entomologist with ecological training for study of the tsetse fly, especially in relation to bush clearance and other problems, is desirable. A pathological laboratory will be necessary for the medical service, and a nutrition adviser should be appointed, as well as a statistician and a soil chemist, competent, in conjunction with the surveying of the units, to carry out the mapping of the main soil types in the areas concerned.

For the third year the programme envisages the continuance of fertilizer work and study of the effect of incorporating humus and of conservation work on the moisture content of the soil, as well as experiments on crop rotations, including studies of the fate of nutrient elements in the soil, particularly nitrogen. The testing of alternative fertilizer materials and methods of application; the suitability of local materials for fertilizer manufacture and other industrial purposes; the investigation of water conservation problems, including drainage, on a 'geographical' scale; positive programmes of plant-breeding for resistance to disease and yield of oil; and the acclimatization of new crops, particularly of fruit and vegetables, are other directions in which research is regarded as likely to yield results of value to East Africa as a whole. In the veterinary field, studies of cattle nutrition are contemplated, and pasture studies should develop from the botanical survey of the earlier years.

This programme indicates the fundamental importance of the contribution of science to the success of the scheme, and on that ground alone the proposals and the report formulating them merit careful study by scientific workers concerned with these fields. Beyond this and beyond the importance of co-operation between men of science and scientific departments in many fields—the Rhodes - Livingstone Institute, as well as the Colonial Research Committee, the Medical Research Council and several Government Departments are all in a position to make invaluable and indispensable contributions—there is the great human interest which is attached to this experiment in human welfare. It is a programme the implications of which reach far beyond the Colonial field itself, and may provide a demonstration of the power of science to contribute to the improvement of standards of living and to increase the resources of mankind. It may open up increasing possibilities in the use of science for the welfare and not the destruction of mankind, and the fulfilment of the hopes which the vision and imagination of such schemes as the Tennessee Valley Authority and the Food and Agriculture Organisation of the United Nations have already raised.

RICHARD JEFFERIES AND THE ENGLISH FARM WORKER

A Classic of English Farming

Hodge and his Masters. By Richard Jefferies. Edited and with an Introduction by Henry Williamson. Pp. 340. (London: Faber and Faber, Ltd., 1946.) 10*s*. 6*d*. net.

IN 1872 there appeared in *The Times* a long and remarkable letter describing the life of a Wiltshire farm labourer. It was so different from the current ideas on the subject that it was drastically criticized by the *Liverpool Mercury*: "A Mr. Richard Jefferies, dating from Coate Farm, Swindon, has managed somehow or other to get two columns and a quarter of the *Times* to air his notions in, and very funny notions they seem to be—there is no doubt that he has moved about amongst hundreds of labourers; but that he has ever adequately seen them in the sense of understanding and knowing them we should be very slow to believe". But Jefferies was not crushed, and seven years later, in 1879, he wrote a series of articles on country life which were published in book form in 1880 under the title "Hodge and his Masters". For some reason or other the book was not re-issued until 1937. Messrs. Faber and Faber have now re-published it with an introduction by Mr. Henry Williamson, who has wisely reprinted the original *Times* letter and the *Liverpool Mercury*'s criticism thereon.

The book was well worth reprinting, for it gives a graphic picture of the Wiltshire countryside in the 1870's, written in Jefferies' usual limpid style and with his unerring instinct for getting at the essentials and yet including sufficient detail to make the picture vivid. He attempts no running narrative; each chapter is self-contained and almost independent of the rest, and there is no final summing up. But all the same, the account is wonderfully clear, and all of Hodge's 'masters' are described in their turn. Hodge is, of course, the farm worker; the masters are the farmer, the squire, the parson, the County Court officials, and at the end, the Board of Guardians, for Hodge, much against his will, ended his days in the workhouse; his wife was dead, his children had emigrated, and the Guardians were precluded from giving outdoor relief by the circumstances that Hodge had saved a little and become part owner of his cottage.

The book was written in 1879—the worst season on record because of heavy persistent rain from hay-time to harvest and beyond. The results were disastrous: the corn gave wretchedly low yields of very poor quality, the land became smothered in weeds, hay became scarce and very dear, the grass was sodden and of desperately poor feeding value, livestock were ill-nourished and disease was widespread. All this is vividly described, but not too gloomily, for there is a stolidity about the countryman, which Jefferies faithfully reproduces, that makes him slow to recognize disaster. Had 1879 stood alone, the damage might well have been repaired, but it was followed by a run of bad seasons and, worse still, wheat began to pour in from North America in unregulated flow, and meat followed suit, so that prices fell and many farmers were ruined. The chapter "Going Downhill" is one of the saddest in the book.

The vividness with which the essential features are described gives the book a very modern feeling. Over and over again one is tempted to forget that it was written in 1879 and not in 1946. The stress laid on the need for mechanization, the talks about artificial manures and hay-driers, the man who, having acquired wealth in the city, sets up as a farmer and proceeds to introduce business methods, but becomes for half the countryside an object of lawful plunder—and loses heavily in consequence—all these appear just as they would if Jefferies had been writing to-day. Happily the modern changes in the countryside, some good, some bad, have not destroyed its fundamental good features. Perhaps most important of all, the sense of responsibility to the land, the live-stock and the community remains; fortunately indeed for us, for it has meant that the output per man-year has increased since 1939 by some 17 per cent, and throughout all that critical period there was no threat of action by the workers against the community. No other primary producers can show such a record: if they could, the nation would not be in its present predicament.

The book can be strongly recommended to all lovers of the English countryside. If a second edition is called for, we hope that editor or publishers will tell us more about Richard Jefferies, for, sad to say, many young people to-day know very little about him; some indeed have never heard of him. But his work deserves to live.

E. John Russell

A TEXT-BOOK FOR ANÆSTHETISTS

The Chemistry of Anaesthesia

By Dr. John Adriani. Pp. ix+530. (Oxford: Blackwell Scientific Publications, Ltd., 1946.) 35*s*. net.

MEDICAL men seeking special qualifications as anæsthetists are expected to acquire a good knowledge of the basic sciences on which anæsthesia depends. A pair of text-books on the physics and chemistry of anæsthesia for use by intending anæsthetists has been published by Blackwell Scientific Publications of Oxford. The author of the present volume, John Adriani, is director of the department of anæsthesia in the Charity Hospital of Louisiana at New Orleans.

The first hundred pages are devoted to inorganic chemistry, including the physical and chemical properties of the gases present in the atmosphere, the principles of flowmeters, absorption apparatus and other equipment used by anæsthetists.

The next two hundred pages give a detailed account of the chemical properties of general anæsthetics and of other drugs used by anæsthetists, including hypnotics, opium alkaloids, local anæsthetics, drugs affecting the autonomic system and analeptics. There are a number of tables giving the chemical formulæ of allied drugs in a form which makes it easy to compare them with one another. This section of the book will be useful for reference, but it is to be hoped that anæsthetists will not be expected to memorize all these detailed facts, most of which will be of little direct use in the practice of their art.

The last two hundred pages deal with the pharmacology of general anæsthesia, with a chapter on local anæsthesia and another on enzymes, vitamins and hormones. This section will be more valuable to anæsthetists than the rest of the book and may interest readers of *Nature*. The various theories of narcosis are impartially set forth. The effects of anæsthesia on the body fluids are discussed, with sufficient information on biochemistry to make the discussion intelligible to those medical men who have forgotten most of what they learned in the earlier parts of their time as students. Chapters are devoted to the physiology of the liver and the kidneys, with an account of the effects of anæsthetics upon them. There is a short account of methods used to estimate the effect of anæsthetics on tissues, and of the fate of anæsthetics in the body.

The book will probably find a market because it provides the information required for one type of examination in a form that is not otherwise available; but it contains a number of errors. For example, the formula on p. 235 for the rate of disappearance of an anæsthetic in the body must surely have been incorrectly copied. The numbering of atoms in the purine ring on p. 278 is not the usual one and does not correspond with chemical names in the text. On p. 289 a unit of pituitrin is defined as the amount required to raise the blood pressure of a dog by 30 per cent. Anyone who knows anything about biological assays is likely to be deeply shocked at this last statement.

There are forty-five pages of reference at the end, arranged according to the chapter, or part of a chapter, in which each work is mentioned. This system is not uncommon, but inconvenient. The reader who wishes to trace a reference must first find out which chapter he is reading by noting the page and referring to the list of contents at the beginning. He must then find the corresponding section of the list of references, and if he opens the book in the middle of one of these sections there is no indication whether he should turn on or back. This list would be easier to use if it contained, on each page, the numbers of the corresponding page of the text.

J. H. Gaddum

RESEARCH IN CANADA

Research in Canada

Planning for the Coming Years. Papers given at the Symposium of the Chemical Institute of Canada, Quebec City, June 1945. Pp. vii + 160. (Sarnia, Ont.: Imperial Oil, Ltd., 1946.)

THE papers in this volume, sponsored by Imperial Oil, Ltd., were presented at the first annual conference of the Chemical Institute of Canada, held at Quebec in June 1945, and although, as might be expected, of uneven merit, afford a conspectus of scientific research in Canada in some respects broader than that given by the annual reports of the National Research Council. Dr. C. J. Mackenzie's contribution, "Government Sponsored Research", goes far beyond the narrower limits which his position as president of that Council might impose, and he discusses the particular problem of the industrial research association in Canada in view of the relatively few large industrial units in Canada. Dr. Mackenzie looks forward to the activities of Government-sponsored laboratories, such as those of the National Research Council, being directed almost exclusively to the more fundamental aspects of applied research; but he indicates that in the meantime the National Research Council will foster industrial research either on a co-operative basis or through agencies of the type of the Mellon Institute. Dr. R. K. Stratford, chief research chemist of Imperial Oil, Ltd., in his contribution "The Co-ordination of Research in Canada", also discusses the relations between fundamental and applied research, emphasizing the importance of maintaining a reasonable balance between the man-power engaged in industrial research and in fundamental research in the universities; and he suggests the establishment of technical institutes to help co-ordinate and improve the efficiency of technical men engaged in field service or development work, a suggestion which is elaborated in some detail by Prof. P. Rion.

"The Role of the Universities in Research" is discussed more particularly by Prof. L. Thomson, who endorses Dr. Stratford's view as to their primary importance, but emphasizes that they are equally the source of expert personnel required in government and industry. Prof. Thomson goes on to emphasize the factors on which the effectiveness of the universities both for teaching and research depend, and stresses not only adequate financial support but also the provision of conditions of service to attract the best men, as does Mr. G. E. Jackson in a paper on "The Provision of Manpower for Research in Canada". Much in these and in the other papers reiterates points made repeatedly in discussions on scientific and industrial research in Great Britain in recent years and in the Barlow Report on scientific staff.

The most interesting paper is possibly that by Dr. H. G. Fox on "Research and Invention in the Law of Patents", in connexion with which attention may be directed to Mr. C. Hollins' discussion of "Patentable Invention" (*Chemistry and Industry*, 170; 1945). After dismissing as invalid in the light of Canadian experience Mr. Wendell Berge's assertion that patents have been used to stifle new enterprise and to limit capacity and production, he proceeds to review the Canadian patent system in relation to research. The situation, he holds, is not entirely satisfactory, first because of faulty administration, due largely to inadequate staffing and parsimonious grants from the Canadian Government—weaknesses which, incidentally, are obvious even outside Canada to anyone who has had dealings with the Canadian Patent Office—and, second, because of its insistence upon invention as a basis of grant of a patent. Dr. Fox develops at some length the implications of this doctrine, which he regards as inimical to organised research and team-work. He agrees that to provide the judges in patent cases with a panel of scientifically or technically qualified persons, as suggested by the Joint Chemical Committee, would assist; but urges that the only satisfactory solution is reform of the law itself to eliminate the criterion of invention and replace it by that of improvement, providing protection where a contrivance or discovery is new and useful, contributing something to the technique of scientific or industrial life or representing a step forward in art. Dr. Fox's history of the outlook on subject-matter is valuable and interesting; but it should be observed that the decline in patent activity illustrated by the graph on p. 86 and referred to on p. 115 is not peculiar to Canada. A corresponding decline is apparent at least up to 1939 in the major industrial countries, including the United Kingdom and Germany as well as the United States. Two minor corrections should be noted. The reference on p. 117 should be to the Trade Marks, Patent and Designs Federation, Ltd., while on p. 118 "Joint Chemical Society" should read "Joint Chemical Committee".

R. Brightman

Annuaire astronomique et météorologique Camille Flammarion pour 1947

(83e année.) Pp. 381. (Paris: Ernest Flammarion, 1947.) 160 francs.

THE *Annuaire* for 1947 follows the usual plan of earlier issues, with a few minor modifications, and maintains its excellent standard. It may be pointed out that amateur astronomers, who are playing an increasing part in astronomical developments, would find this publication a very useful handbook as complementary to the "Nautical Almanac". Much of the information is tabulated in a very concise and convenient manner, and also various branches are dealt with which are outside the scope of the "Nautical Almanac". Thus, lists of comets, meteor radiants, distances, spectral classes, temperatures, diameters of stars, of variable stars, etc., and also interesting phenomena for each day, provide very handy material for amateurs who might otherwise find it necessary to search different books of reference for such information. Members of the British Astronomical Association, who depend on the Association's Handbook for data on different sides of astronomy, would find the *Annuaire* a useful addition to their bookshelves. Star maps for each month of the year will prove acceptable to many readers.

The portion dealing with terrestrial magnetism and meteorology is very short, the latter occupying less than three pages. One wonders whether this could not be enlarged a little, with some advantage to certain readers. As pointed out, however, on p. 19, it is very unlikely that this will be done in the near future, and only in so far as meteorology makes substantial progress can it claim the right to be included in the *Annuaire*. Four pages are devoted to the physics of the earth, and these deal solely with seismic disturbances in France and other countries.

M. D.

General Chemistry

By Prof. Eugene P. Schoch, Prof. William A. Felsing and Prof. George W. Watt. (International Chemical Series.) Pp. xiii+540. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 20*s*.

THIS is an elementary text-book on the lines of most good American works of its kind. The material is presented in a selected order, in many cases the elements being separated from their compounds in different chapters, and there is emphasis on industrial uses. The chapters on physical chemistry are interspersed among those on inorganic chemistry, and on the whole the book lays more emphasis on this side. In some cases the sections on inorganic chemistry are very short, ozone having only one page, for example. There is a whole chapter on nuclear chemistry, and four chapters on selected topics in organic chemistry. There are references to American literature, and questions, at the ends of the chapters.

Since the book is in a second edition, it is in general accurate, but a few slips were noticed. It is surely incorrect to emphasize so strongly (p. 40) that a catalyst in a reaction "has not been altered in any way", and this is probably incorrect for the reaction dealt with. Chlorine dioxide does not, as was proved by the American chemist Bray long ago, react with water to form chlorous and chloric acids (p. 397, where the formula of chlorine dioxide is given as Cl_2O in the equation). The old chain formulæ of the sugars are given (p. 480). The portrait on p. 491 is of the wrong Perkin.

These are trifling errors, and the book as a whole is carefully written and based on modern theory. The sections on oxidation-reduction reactions, acids and bases, and electrochemistry may be mentioned as especially good. Although the book would be found interesting by teachers, it would not fit into English courses; some subjects are dealt with too summarily, and some in much too detailed a way.

Tables of the Modified Hankel Functions of Order One-Third and of their Derivatives

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 2.) Pp. xxxvi+235. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1945.) 10 dollars. 55*s*.

THE new I.B.M. Automatic Sequence Controlled Calculator at Harvard was recently described in *Nature* (**158**, 567; 1946). The volume now before us contains the first of a series of tables produced by the machine in its spare time!

The differential equation the solutions of which are tabulated is that of Stokes, namely,

$$\frac{d^2u}{dz^2} + zu = 0,$$

which occurs in problems of wave propagation. Solutions of this equation for real z have recently been tabulated under the direction of J. C. P. Miller (B.A. Mathematical Tables, Part-Volume B, 1946) as the Airy integral.

Although the general solution of this equation can be written in terms of Bessel functions of order one-third, the direct tabulation, as is here done, is preferable. The real and imaginary parts of two fundamental solutions are given to eight decimals at intervals of 0·1 in x and y up to $|x + iy| \leqslant 6$.

The next tables to appear in this series are of $J_n(x)$ at a fine interval and to high values of n and x.

L. J. COMRIE

Characterisation of Organic Compounds

By Dr. F. Wild. Pp. viii+306. (Cambridge: At the University Press, 1947.) 18*s*. net.

ADVANCED students of organic chemistry and also research workers in this field will find in Dr. Wild's book a useful and comprehensive guide in the characterization and identification of organic compounds belonging to most of the ordinary types. The work is essentially for use in the laboratory; it affords practical details, either directly or through references to the literature, for the preparation of suitable derivatives and of the special reagents needed; and there are reference tables for each important type of characterizing compound described. Details for the preparation and application of some of the newer and less familiar reagents are particularly useful. As an example of the treatment adopted, the preparation of solid derivatives of alcohols is described, within the compass of eleven pages, by means of esterification with acid chlorides, isocyanates, azides, acid anhydrides and pseudo-saccharin chloride; several miscellaneous methods follow. An appended table gives the boiling-point or melting-point of the original substance and of a maximum of fourteen derivatives for a list of fifty-seven alcohols. The book is well documented, indexed and printed. An introductory section contains eleven diagrams of apparatus.

J. R.

ACOUSTICAL QUANTA AND THE THEORY OF HEARING

By Dr. D. GABOR
British Thomson-Houston Co. Research Laboratory, Rugby

IN popular expositions of wave mechanics, acoustical illustrations have been used by several authors, with particular success by Landé[1]. In a recent paper on the "Theory of Communication"[2] I have taken the opposite course. Acoustical phenomena are discussed by mathematical methods closely related to those of quantum theory. While in physical acoustics a new formal approach to old problems cannot be expected to reveal much that is not already known, the position in subjective acoustics is rather different. In fact, the new methods have already proved their heuristic value, and can be expected to throw more light on the theory of hearing. In my original paper the point of view was mainly that of communication engineering; in the following survey I have emphasized those features which may be of interest to physicists and to physiologists.

What do we hear? The answer of the standard text-books is one which few students, if any, can ever have accepted without a grain of salt. According to the theory chiefly connected with the names of Ohm and Helmholtz, the ear analyses the sound into its spectral components, and our sensations are made up of the Fourier components, or rather of their absolute values. But Fourier analysis is a timeless description, in terms of exactly periodic waves of infinite duration. On the other hand, it is our most elementary experience that sound has a time pattern as well as a frequency pattern. This duality of our sensations finds no expression either in the description of sound as a signal $s(t)$ in function of time, or in its representation by Fourier components $S(f)$. A mathematical description is wanted which *ab ovo* takes account of this duality. Let us therefore consider both time and frequency as co-ordinates of sound, and see what meaning can be given to such a representation.

If t and f are laid down as orthogonal co-ordinates, a diagram is obtained which may be called an 'information diagram' (Fig. 1). A simple harmonic oscillation is represented by a vertical line with abscissa f, a sharp pulse (delta function) by a horizontal line at the 'epoch' t. These are extreme cases. In general, signals cannot be represented by lines; but it is possible to associate with them a certain characteristic rectangle or 'cell' by the following process, which at first sight might perhaps appear somewhat complicated.

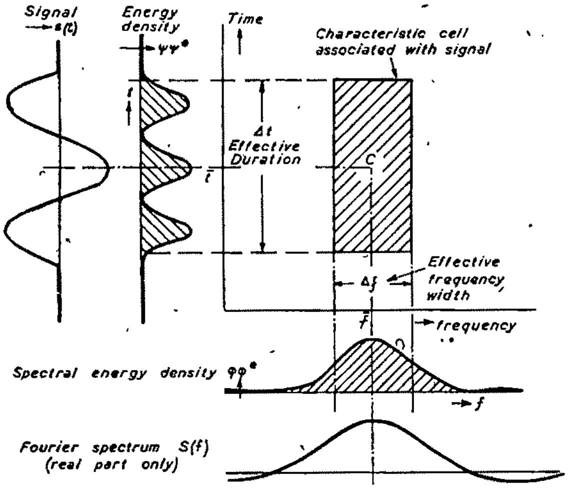

Fig. 1. CHARACTERISTIC RECTANGLE OF A SIGNAL IN THE INFORMATION DIAGRAM

Consider a given signal described as $s(t)$ in 'time language' and by its Fourier transform $S(f)$ in 'frequency language'. If $s(f)$ is real, $S(f)$ will be in general complex, and the spectrum will extend over both positive and negative frequencies. This creates an unwelcome asymmetry between the two representations, which can be eliminated by operating with a complex signal $\psi(t) = s(t) + i\sigma(t)$, where $\sigma(t)$ is the Hilbert transform of $s(t)$, instead of with the real signal $s(t)$. This choice makes the Fourier transform $\varphi(f)$ of $\psi(t)$ zero for all negative frequencies. Next we define the 'energy density' of the signal as $\psi\psi^*$, where the asterisk denotes the conjugate complex value, and similarly $\varphi\varphi^*$ as the spectral energy density. In Fig. 1 the two energy distributions are shown as shaded areas. The two are of equal size; that is, the total energy of the signal is the same by both definitions. We can now define a 'mean epoch' $\bar{t}$ of the signal, and similarly a 'mean frequency' $\bar{f}$, as the co-ordinates of the centres of gravity of the two distributions. This gives a point C in the information diagram as the centre of the signal. Going a step further, we define the 'effective duration' Δt and the 'effective frequency width' Δf of the signal by means of the mean square deviations of the two energy distributions from the mean values $\bar{t}$ and $\bar{f}$. In the figure these appear as the inertial radii of the two shaded areas. For reasons which will become evident later, it is convenient to define Δt and Δf as $2\sqrt{\pi}$ times the respective inertial radii†. With these definitions a mathematical relation, the Schwarz inequality, can be applied, which states that

$$\Delta t \, \Delta f \geqslant 1 \; ; \quad . \quad . \quad . \quad (1)$$

that is to say, *the area of the characteristic rectangle or cell of a signal is at least unity*. This is the exact formulation of the uncertainty relation between time and frequency. It is clear now that what we have obtained is a classical model of one-dimensional static wave mechanics, in which unity replaces Planck's constant h. Formally this 'quantum' is represented by a cell of unit (dimensionless) area in the information diagram. Its physical significance becomes evident from the following consideration.

If in a time interval T a signal is expanded in a Fourier series, there will be T complex Fourier components per unit frequency band-width. Thus we can say that the information diagram contains one complex datum per unit area. (This, of course, is to be considered as an asymptotic theorem for large areas, as by equation (1) we cannot analyse the information area into cells of less than unit order.) We see now that the quanta in this model of wave mechanics are *quanta of information*. Each quantum represents one complex numerical datum or two real data.

This result, in combination with the uncertainty relation (1), suggests the question whether there are signals for which the inequality turns into an equality, and which could be used for the representation of quanta. It can be shown that such simplest or 'elementary' signals exist, and their form is

$$s(t) = \exp - \alpha^2(t - t_0)^2 \, . \exp i2\pi f_0 t, \qquad (2)$$

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† In the original paper the factor was $\sqrt{2\pi}$ instead of $2\sqrt{\pi}$, so that $\frac{1}{2}$ appears in equation 1 instead of unity. The present choice is more advantageous for a direct comparison with quantum theory.

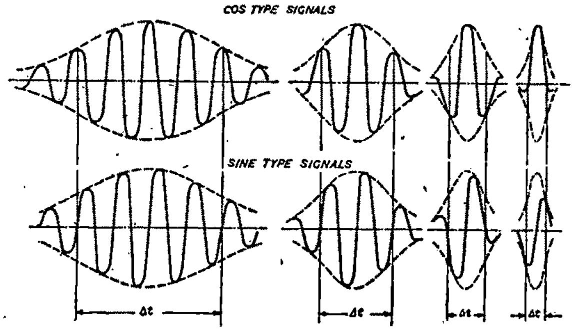

Fig. 2. ELEMENTARY SIGNALS

where α is a real constant. Thus the elementary signals are harmonic oscillations of any frequency f_0, modulated by a probability pulse. Their Fourier transforms are of the same mathematical form

$$S(f) = \exp - (\pi/\alpha)^2(f - f_0)^2 \cdot \exp i2\pi t_0 f. \quad (3)$$

The real components of the elementary signals are conveniently specified as cosine-type and sine-type signals, and are illustrated in Fig. 2 for several values of the constant α, which is connected with the effective duration and effective band-width by the equations $\Delta t = \sqrt{\pi}/\alpha$ and $\Delta f = \alpha/\sqrt{\pi}$. If $\alpha = 0$, the elementary signals become simple harmonic oscillations; if $\alpha = \infty$, they turn into the delta function and its derivative.

These elementary signals can be used for the representation of quanta of information, as any arbitrary signal can be expanded in terms of them, with any choice of the constant α. That is to say, we can expand a signal by dividing up the information area into unit rectangular cells of any aspect $\Delta t/\Delta f = \pi/\alpha^2$, and by associating with every cell an elementary signal with a complex amplitude factor c_{ik}. We thus obtain a sort of matrix, as illustrated in Fig. 3. This method of analysis contains 'time language' and 'frequency language' as special extreme cases. If the cells are infinite in the time direction we obtain Fourier analysis; if they are infinite in the frequency direction we obtain an expansion into delta functions, that is to say, the function $s(t)$ itself.

Expansion into elementary functions is in general a rather inconvenient mathematical process, as they do not form an orthogonal set. There exists, however, an experimental method, which, though not equivalent, gives somewhat similar and very valuable results. This is the method of 'sound spectrography' developed by the Bell Telephone Laboratories during the War, and published after the original paper by the author was written and accepted[3]. There is no space here to describe this method and the difference between 'sound portraits' and matrices of elementary signals, but it may be noted that sound portraits are not complete representations of the original sound, though they contain most of its subjectively important features.

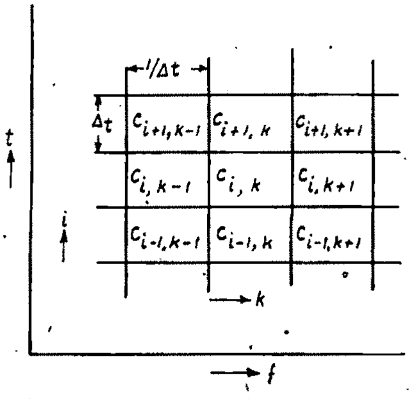

Fig. 3. MATRIX OF ELEMENTARY SIGNALS REPRESENTING AN ARBITRARY SIGNAL

It is to be expected that the analysis of hearing sensations will prove a fruitful field for the new methods of representation, and the results so far obtained seem to indicate very clearly that the 'quantum of sound' is a concept of considerable physiological significance. Acoustical workers have collected a large amount of material on the threshold of ear discrimination for epoch and frequency differences. It appears that at least a good part of these results can be summed up in the statement that *the ear possesses a threshold area of discrimination of the order unity.*

One series of experiments which were analysed were those of Bürck, Kotowski and Lichte[4]. Their object was the threshold of time discrimination in different frequency-ranges. Mach showed that if a sinoidal oscillation is sounded for a few cycles only, the ear will hear it as a noise, while after a minimum duration of about 10 milliseconds it will be heard as a short musical note, with ascertainable frequency. The authors carried out a series of tests on this phenomenon, and in a second series° went a step further. In these tests the intensity was doubled after a certain time from the start. If this was less than a certain minimum (21 msec. at 500 cycles), the sound could not be distinguished from a note which was sounded from the start with double intensity; beyond this the step could be heard as such. One could say that in the interval between 10 and 21 msec. the ear has just got ready to register a second, distinct sensation.

Another series of experiments is due to Shower and Biddulph[5] and relates to the threshold of differential frequency discrimination of the ear. Their technique was quite different. The frequency of a note was modulated between narrow limits, and the minimum frequency swing was noted which gave the impression of a 'trill'. At 500 cycles this minimum swing was 2·3 cycles. Below this the trill could not be distinguished from a pure note. The cycle of modulation was so chosen that it gave the finest frequency discrimination (0·5 sec. for the full cycle). In these experiments, as in those of Bürck, Kotowski and Lichte, intensity played no essential part, provided that the tests were carried out at a level of good audibility.

Though it might appear that in these experiments the frequency discrimination of the ear was tested, and in the previously mentioned experiments the time response of the ear, in reality, of course, both time and frequency are involved in both cases. In the experiments of Bürck, Kotowski and Lichte, the effective width of a sinoidal oscillation which has lasted only for a finite time has to be considered. In the tests by Shower and Biddulph the time of 0·25 sec. is necessary to notice one 'up' or 'down' of the frequency. Thus from the time and frequency intervals involved in each case it is possible to form a product, the 'threshold area', in which the ear was capable of registering one sensation only, and which must be exceeded if it is to register a second. The numerical value of this area is to some extent a matter of definition. With the conventions adopted in the original paper, the threshold area calculated from the data of Bürck, Kotowski and Lichte was 1·05 at 500 cycles and 1·5 at 1,000 cycles, while the figures of Shower and Biddulph gave 1·17 in both cases. No such accuracy can of course be claimed, and the absolute values depend on the exact definition, but by any reasonable convention the threshold area is found to be of the order unity, that is to say, near the 'acoustical quantum limit'. It must be understood, of course, that there is an important difference between an acoustical quantum as registered by a physical measuring instrument, and as registered by the ear. In the experiments considered the ear was called upon only to answer 'yes' or 'no' to a simple question. To a measuring instrument, on the other hand, a quantum of information conveys a complex numerical datum (two real data), and every exact datum carries in itself an infinite number of 'yes's' and 'no's'. The difference is expressed by talking of 'discrimination' in the case of the ear and 'registering' in the case of a measuring instrument. In this sense we can say that, at least in simple experiments, the best ears in the optimum frequency-range can just about discriminate one acoustical quantum.

The importance of this result lies in the remarkably wide range of aspect ratios in which it seems to apply. As shown in Fig. 4 for the case of signals near 500 cycles, the threshold area does not vary appreciably while the time interval varies from about 20 to 250 msec.; that is to say, by more than a factor of ten. Within these wide limits the ear has the power of searching out by an automatic adjustment the finest details in the sound pattern offered to it. If a short sound strikes the ear, with poorly defined frequency, the time discrimination is of the order of 20 msec. If the sound is prolonged, so that its effective band-width shrinks to a few cycles per second only, the frequency discrimination of the ear keeps in step with this process for at least a quarter of a second. An old problem of physiological acoustics appears here in particularly sharp relief. No simple physical system of resonators could account for this degree of perfection. Resonators can be tuned to wide bands or to narrow ones, but not to both simultaneously. From physiological data, and in particular from the experiments of Wegel and Lane[6] on 'masking', it is practically certain that the ear resonators are very strongly damped, with decay times of the order of 10 msec. or less. They are tuned to bands approximately as wide as would account for the results of Bürck, Kotowski and Lichte, but not for those of Shower and Biddulph, which would require for their explanation decay times at least ten times longer. Thus the postulation of a second mechanism in the ear, which accounts for its apparent progressively refined tuning in the case of prolonged sounds, appears to be inescapable.

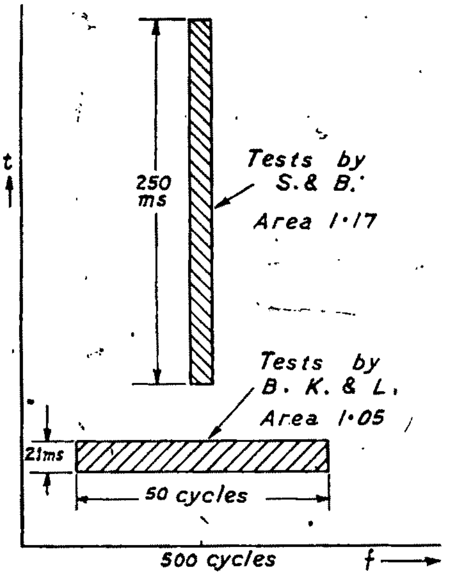

Fig. 4. THRESHOLD AREAS OF THE EAR AT 500 CYCLES/SEC.

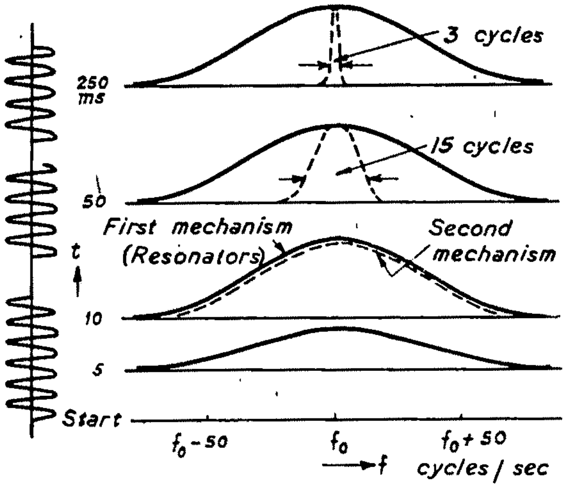

Fig. 5. THE TWO MECHANISMS OF HEARING. IF A NOTE IS SOUNDED FOR MORE THAN ABOUT 10 MSEC. THE RESONANCE PATTERN OF THE INNER EAR REMAINS UNCHANGED; BUT A SECOND MECHANISM STARTS SEARCHING FOR THE MAXIMUM OF EXCITATION AND LOCATES IT WITH AN ACCURACY WHICH INCREASES UP TO ABOUT 250 MSEC.

The role of the two 'mechanisms' is roughly illustrated in Fig. 5. The first is probably the real mechanism of the ear resonators; the second is almost certainly non-mechanical. One might be tempted to locate it in the brain, but this assumption is not unavoidable. It might well be a new phenomenon in nervous conduction, and could be explained by the hypothesis that conduction in adjacent nerve fibres is to some extent unstable, so that the more strongly excited fibre gradually suppresses the excitation of its less strongly excited neighbour. Thus if a pure note is sounded for a sufficient time, less and less fibres will be excited, until finally only the fibre corresponding to the position of maximum amplitude in the basilar membrane remains in action. This makes it possible to ascertain the frequency with far greater accuracy than one would expect from the broad tuning of the mechanical resonators. It would be most interesting, though probably very difficult, to prove or to disprove this effect, perhaps by a further refinement of the techniques of Galambos and Davis[7].

It is interesting to note that we begin to perceive a sound as 'musical' just at the point where the second mechanism takes over. Speech would be perfectly intelligible by the first mechanism alone; but the second is necessary to enable us to appreciate music.

Finally, it may be asked whether quantum theory has anything to learn from the acoustical model. In a formal sense the answer must be, of course, in the negative. From the fact, however, that two different fields admit the same formal treatment it follows that, so far as the mathematics goes, there can be nothing in one which is not implicit in the other. But familiar models of less familiar phenomena have at least one advantage. They make it easier to distinguish between intrinsic features of the phenomenon, and others which are introduced by the method of analysis. One might be inclined to think that sharply defined states, characterized by integral numbers, are peculiar to quantum phenomena, or at least that they require special mechanisms to imitate them classically, such as strings or membranes. But we have seen that in the acoustical model the integers emerge as a part of the mathematical background before any physical phenomenon has appeared on the stage. The ultimate reason for the emergence of 'acoustical quanta' is that we have viewed the same phenomenon simultaneously from two different aspects, and described it by two 'quantities of interest', time and frequency. Any number of other classical models may be found, if only we ask simultaneously two kinds of questions about the same thing, or perform two lines of experiments on it, provided that the questions are neither identical nor independent.

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A CHEMICAL BICENTENARY AT THE UNIVERSITY OF GLASGOW

By Dr. ANDREW KENT
Department of Chemistry, University of Glasgow

ARISTOTELIAN physics and astronomy had had place in the arts curriculum at the College of Glasgow ever since King Jamie wi' the Fiery Face welcomed the advent of Scotland's second University (1451). In the eighteenth century a more modern science was recognized by the institution of chairs in natural philosophy (1717) and practical astronomy (1760).

Between these events in the Faculty of Arts, William Cullen completed the first course of lectures in chemistry (1747). This lectureship in the Faculty of Medicine was part of a renewed and finally successful effort to provide his *Alma Mater* with the prestige of a comprehensive medical school, the steady expansions of which included the later regius chair of chemistry (1818).

Cullen was perhaps the greatest physician to teach chemistry in this or any other British university. Although there is some evidence that he would have preferred to place the subject in the wider field of arts, there was, of course, nothing unusual in its association with eighteenth-century medicine. The notable factors are the broad and enlightened views which this polymathic personality adopted in the scope and emphasis of his teaching, and his lasting influence on the new department.

During 1747–1874 the Department was headed, for all but three years, by professional physicians. Although the degree of B.Sc. was first conferred in 1873, and the belated Faculty of Science (1893) included lectureships in organic chemistry (1898), in metallurgical chemistry (1899) and in "Physical Chemistry including Radio-activity" (1904), the chair of chemistry was first detailed in the calendar under 'Faculty of Science' only in 1920. Although even the nineteenth-century class of 'Practical Chemistry' pursued a course of "bases and acids, poisons and the pharmaceutical compounds", there was always a group of 'laymen' in the principal class of systematic chemistry and in the laboratory. For these freedoms of outlook and emphasis a lasting gratitude is due to William Cullen.

So the portentous association of Joseph Black (1756) with James Watt has its place in world history. John Robison (1766) was not a physician. William Irvine (1769) and T. C. Hope (1787) were physicists of note. Robert Cleghorn (1791) may have concentrated unduly on his duties to the students of medicine; but with Thomas Thomson (1817), the first regius professor, the lectures certainly reverted to a wider scope, which was undiminished during the tenure of his successor, Thomas Anderson (1852). With the advent of John Ferguson (1874) the medical dynasty is at an end: the now legendary 'Soda' took an active part in framing the new Faculty of Science, and in completing a near century of service by the first three regius professors. The fourth, G. G. Henderson (1919), guided the Department to its present Faculty. The 'auld alliance' has since been represented by a lecturer in 'Chemistry for students of Medicine' and by the research interests of George Barger (1937) and of James W. Cook (1939). In the Gardiner chair T. S. Patterson (1919) and J. Monteath Robertson (1942) have emphasized the modern significance of organic and of physical chemistry.

These heads of department, six of whom were products of the chemistry class, have seen their opportunities grow fiftyfold since some twenty students first gathered around Cullen. Since 1861 they have enjoyed the support of official colleagues such as, among others, William Ramsay, J. J. Dobbie, Frederick Soddy and C. H. Desch. The present teaching and research staff, some thirty strong, installed in a new and well-equipped building, have also behind them two hundred years of provocative tradition.

The Department has not only carried out its natal responsibilities in the teaching of medicine. It has helped to fashion in earlier days physician-scientists like Joseph Black, John MacLean of Princeton, and Thomas Graham, professional scientific workers like John Robison, William Thomson (Lord Kelvin) and (Sir) William Ramsay, *entrepreneurs* like Charles Macintosh and William Couper.

The Duke of Hamilton, descendant of Cullen's friend and patron, will preside over the first of a bicentenary series of lectures to be given this month by Dr. Douglas Guthrie, Prof. John Read, Dr. Alexander Fleck and Prof. A. R. Todd. Later, it is intended to publish a commemorative volume, edited by the present writer, in which scientific men of diverse interests and of many colleges will combine in tribute to those early pioneers whose far-sighted ambitions have eventuated in the multifold activities and the wide influence of the school of chemistry at the University of Glasgow.

The careless dust of time has overlaid some points of interest. It is not easy now to discover the type of chemistry taught by Cleghorn during a tenure of the lectureship (1791–1817) which included many exciting advances in the subject; an era much given to portraiture and cartoon has left no traceable reproduction of the lineaments of William Irvine; memorialists have often concentrated on the various medical chairs which were held concurrently or successively by the lecturers in chemistry. Enough remains to afford a reasonable pride in associations with hermetic antiquity.

Lavoisier and Dalton were to find paladins in Hope and Thomas Thomson, but Boerhaave and Stahl were the first pedagogic exemplars. If alchemy were never countenanced, the 'Four Elements' and the *Tria Prima* were topics of critical discussion in the earliest lectures. From that point onwards the making of modern chemistry is mirrored in the teaching and researches of its exponents at Glasgow, and in the later activities of those thousands whose names have been enrolled in the class of chemistry since 1747.

TAXONOMY OF AQUATIC INSECT NYMPHS AND LARVÆ

By Dr. T. T. MACAN

Laboratory of the Freshwater Biological Association,
Wray Castle, Ambleside, Westmorland

ALMOST any collection of freshwater animals will contain a high proportion of insects in the larval or nymphal stage, and a number of these cannot, at present, be named with certainty. The work of many biologists, whether their interest be in ecology, physiology or the food of fish, is affected by this gap in our knowledge, and the importance of closing it need not be stressed. It is the belief of the Freshwater Biological Association that, with sufficient co-operation from workers in other parts of the country, it should be possible, within a few years, to produce keys for the identification of the aquatic stages of all the important groups, except the Diptera. The purpose of this article is to appeal for this co-operation, to which end it includes brief notes on the existing systematic literature of the various groups and a short account of some of the methods of rearing adults from their nymphs or larvæ.

It is hoped that some workers in other laboratories may be induced to turn their attention to systematic studies, and the Freshwater Biological Association is prepared to give all the assistance it can. Others may be able to help by breeding out the species occurring in their own neighbourhood and sending the material to Wray Castle to be described.

The Ephemeroptera and Odonata are under investigation at the moment at Wray Castle. The most urgent need is the description of those species at present not described in any language; but it is also desirable to redescribe and figure some of the species already known, as almost all the existing literature is based on Continental material and the illustrations do not conform to a uniformly high standard.

The Coleoptera and Hemiptera, which are aquatic throughout life, are considered of less importance at the present moment. The position of the other main orders with aquatic nymphs or larvæ is as follows:

Plecoptera. Hynes[1] has described twenty-six out of the thirty-four probable British species, and two have been described since.

Ephemeroptera. Schoenemund's[2] key to the German species includes thirty of the forty-seven British species. Descriptions of some of the remaining seventeen are scattered through the literature. The biggest gap is the genus *Baëtis*, common and widespread in Britain and an important element in almost any stream or river. There are nine British species, but the nymphs of only three have been described, and one of these is probably associated with the wrong adult.

Odonata. Lucas[3] gives a key to the nymphs of all the British species, but experience at Wray Castle suggests that some of the species are distinguished on insufficient material, and the key does not always give the right answer. May[4] states that sufficient information to make a key to the subfamily Agrioninæ or the genus *Sympetrum* is not available. The group clearly requires further study.

Trichoptera. The most complete key, that given by Rousseau[5], is somewhat out of date. A revision of the larvæ of the group is being undertaken by Dr. N. E. Hickin, who has so far described some twenty of the British species (see Hickin[6] for list of references).

Diptera. Complete keys to some of the smaller families, for example, Culicidæ[7] and Simuliidæ[8] exist; others are among the least known of all the aquatic animals. The outstanding gap is the Chironomidæ, a very large family and one of great importance in freshwater biology. In spite of detailed work in Germany most larvæ can only be separated into species groups. Reference may be made to Goetghebuer and Lenz[9]. Separation into groups can also be effected by the use of Johannsen's[10] keys, although this author is primarily concerned with the American fauna.

Many Ephemeroptera and Plecoptera live in flowing water which is always cool and well oxygenated. Hynes[1] describes a technique for rearing the nymphs which are collected in such places, and the apparatus is figured by Worthington[11]. Series of flat enamel dishes are placed on sloping shelves one below the other. Water entering the top dish of each series from a tap drips from one dish to another. Each dish is provided with stones for the nymphs to cling to and is covered with a sheet of mosquito netting on a wire frame. It is necessary to transfer newly emerged Ephemeroptera to a small tube for a day or two, in order to allow the imago to emerge from the sub-imago. Both nymphal skins and adults should be preserved in 2½ per cent formalin, the adults being first wetted in 70 per cent alcohol.

Stream-dwelling Ephemeroptera have, however, been reared in stagnant conditions where a supply of river water was immediately available. Useful collections have also been made by catching emerging sub-imagines in the field. A large collection of nymphs is made; those which, from their silvery appearance, are evidently about to emerge, are sorted into a dish, the collection is then watched, and each sub-imago is caught as it emerges.

Most Odonata inhabit stagnant waters and are easier to rear. They may be kept in pie dishes without running water, one nymph to a dish or they will devour one another. A stick or piece of reed should be provided for the nymph to crawl up before emergence. Each dish should be covered by a cage, though, if this is not possible, and the dishes are in a room, of which the doors and windows can be kept closed, it is seldom that an adult is lost or cannot be associated with the skin from which it came. The adult should be caged for several days after emergence, so that the colours may develop. The brilliance of wild specimens is never attained by captives, but the colours develop sufficiently for systematic purposes. Adults and nymphal skins should be preserved in 70 per cent alcohol and kept in the dark.

The cast skins of exopterygote insects are sufficient for taxonomic purposes, but it is always desirable to have some preserved nymphs from the same locality.

Detailed descriptions of rearing techniques are given by Galtsoff *et al.*[12].

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OBITUARIES

Prof. B. A. McSwiney, F.R.S.

In the sudden and most untimely death of B. A. McSwiney on March 8, physiology and physiologists have suffered a most grievous loss. At a time when enthusiasm, energy and wisdom are conjointly needed for the development of medical education and its safe progress in a period of transition, the University of London and the Medical School of St. Thomas's Hospital have lost a professor and a dean who possessed these qualities in abundance.

McSwiney's scientific career, apart from the war years, was largely orthodox. After a year as lecturer in Leeds, he became lecturer in experimental physiology in the University of Manchester and had the good fortune to work in that laboratory when, under the stimulus of A. V. Hill, it was awakening from a long sleep. His early publications reveal an interest in the development of apparatus for teaching and research which he never lost; but it was not until 1923 that he started working on two quite different subjects which eventually were to shape all his subsequent activity. With Crichton Bramwell and A. V. Hill he published a paper on the velocity of the pulse-wave in man, and a year later, with the late E. D. McCrea, J. W. Morison and J. S. B. Stopford, one on their work on the normal movements of the stomach.

The innervation of the stomach remained McSwiney's chosen interest, and into the morass of conflicting statements, bad experiments and misleading results which confuse the literature he plunged with unabated energy. His work has revealed many of the sources of error which have beset previous workers and has formed a firm scaffold of sound experiment within which others may build. It is of interest to follow the directions in which the problem of gastric innervation led him. He followed at one time the attractive by-path of the physiology of isolated smooth muscle; he developed an elegant nerve – smooth muscle preparation which permitted an approach to be made to the analysis of the peripheral interaction of vagal nerve volleys; and, at the other end of the scale, he and W. R. Spurrell developed a method of outlining the stomach so that its activity could be observed radiographically, without the disturbance and abnormality of an opaque meal.

But this was to take place some years hence. In the meantime, at Manchester, the University had decided to start an honours school of physiology, and it was in the intimate teaching of the chosen few that McSwiney reached his peak. He was obviously too good to last long as a lecturer, and in 1926 he was appointed to the chair of physiology in Leeds.

Here was a splendid opportunity; a relatively small department was ripe for development, and there was the prospect of the extension of the medical school at an early date. McSwiney set to with gusto to build a Physiology Department second to none in the provinces. The old building was reconstructed internally, and, in a few years time, a new building rose which bore the unmistakable stamp of the foresight, skill and energy of the prime mover in its completion. Yet in spite of this interest in bricks and mortar, he was building within his laboratory a research team of great potential. He paid the inevitable penalty of losing men as he made them, but it must have been a source of pride to him to know that eight of his staff at Leeds eventually went to chairs, or posts of equivalent rank. He paid again in the energy he expended, willingly and happily; but the result was a peculiarly happy and friendly laboratory.

It was towards the end of his stay in Leeds that McSwiney published a paper on the afferent fibres from the abdominal viscera. This was the first of a long series with a number of different collaborators, and in it McSwiney had obviously found the subject of his heart. The technique employed was apparently simple, suggesting that little more was needed than observation of the pupil and excitation of nerves by the homely pinch or an induction shock. It demanded, however, the exercise of the experimenter's full artistry to maintain the integrity of labile reflexes in animals exposed to extensive surgical interference, and a most rigid exclusion of a multitude of complicating factors. McSwiney and his colleagues were building a fine structure of knowledge on visceral afferent pathways, much of it with direct application to human medicine. It is to be hoped that his death has not brought the work to an end.

McSwiney left Leeds in 1936 to succeed the late John Mellanby as professor in the Sherrington School of Physiology, St. Thomas's Hospital, and here he set out to continue the work so successfully started in Leeds; but not for long, as he was soon involved in the turmoil of war and evacuation of the Medical School to Godalming. Ordinary research work came to a standstill, and his laboratory undertook practical problems of wound shock and oxygen therapy. With the return of peace his unflagging energies were devoted to the return of his medical school to its normal activities and to the repair of the spiritual and physical damages of war.

No comments on McSwiney's career would be complete without reference to the service which he gave to the Physiological Society. He became a member in 1920 and served on its committee during 1928–34. He was then elected treasurer of the Society, and fulfilled this onerous and responsible task for ten years, at a time when the rapid development of the Society demanded a wise and careful control of its finances. He was in this, as in so many of his activities, supremely competent and effective. His election to the Royal Society in 1944 held out the prospect of widening further the scope of the services he might give to science, great as they had already been.

In the memory of many, McSwiney will remain as an administrator and organiser; but good as he was at these tasks and great as was his flair for the strategy and tactics of the committee, his real place was as an inspiration and guide to his younger colleagues. He himself would never have claimed to be a great investigator, but those of us who had the privilege of working with him know that he had that peculiar quality of leadership which brought out the best in his collaborators in a happy spirit of comradeship.

G. L. BROWN

Prof. Gregori Aminoff

GREGORI AMINOFF, head of the Mineralogical Department of the Museum of Natural History (Riksmuseum), Stockholm, died on February 11, 1947. His death was caused by heart disease, which had during the last few years of his life greatly reduced his capacity for work.

Aminoff, who was born in 1883, belonged to an old Russian Boyar family, a member of which became a Swedish subject in the year 1612. He studied science in Stockholm and obtained his first academic degree in Uppsala in 1905. A strong artistic inclination caused him then to change his profession, and for several years he practised as an artist and studied art in France and Italy. About 1913 his old interest in science became predominant, with the result that he returned to studies in mineralogy. Aminoff's thesis for his doctorate, a crystallographic treatise on calcite and barytes from Långbanshyttan, appeared in 1918, and in the same year he was appointed lecturer in mineralogy and crystallography in the University of Stockholm.

In 1918 the Mineralogical Institute of the University of Stockholm acquired equipment for the X-ray investigations of crystals, and Aminoff was the first to use this apparatus, thus introducing X-ray methods into Sweden. At first he studied several simple structures, and among them found the first representatives for the *C* 6 (brucite and pyrochroite) and *B* 8 (nickel arsenide) types. His very extensive studies over a period of several decades of the minerals from Långban also included much X-ray work.

In 1923 Aminoff was appointed a professor and head of the Mineralogical Department of the Museum of Natural History in Stockholm. After he had obtained adequate laboratory equipment in the Museum, he could take up his research work in the new surroundings. The Långban minerals occupied much of his time, but he also devoted himself to general problems, for example, the mechanism of evaporation and dissolution of crystals. His theoretical study of the contact zone between the two individuals of a twinned crystal is of great value. Aminoff also made use of electron diffraction, as, for example, in his study of the oxidation of zinc sulphide crystals. In this case the known properties of the oxide and sulphide lattices explained the observed relative orientations of the two lattices, but could not explain the non-appearance of some orientations. In the studies last mentioned, as in much other work, Aminoff was assisted by his wife, Birgit Broomé-Aminoff.

In later years Aminoff was very interested in geochemical problems and made use of X-ray spectroscopy for his analytical work. He also spent much time trying to improve the technique of this method. Some of his latest papers (see, for example, *Nature*, April 20, 1946, p. 517) contained descriptions of his efforts to obtain large dispersion by using ground instead of natural crystal faces.

Aminoff was a born investigator who carried on his research for the sake of science. He was a very modest man of retiring disposition. This, together with the non-educational character of his institution, isolated him rather from the wider circles of Swedish science. But he never felt happier than when a friend dropped in at his laboratory with whom he could discuss his research problems.

G. HÄGG

Prof. Fred Vlès

FRED VLÈS, zoologist and biophysicist, professor in the Faculty of Medicine at Strasbourg, died on July 2, 1944, at the age of fifty-nine; he was one of a convoy of 2,500 political prisoners, taken by train from Compiègne to Dachau, of whom only 1,500 arrived alive. He had been arrested by the Gestapo at Clermont-Ferrand, where the University of Strasbourg had been evacuated. When warned that the German police were looking for him, he refused to hide for fear of possible reprisals on his colleagues.

Vlès had been a pupil of Yves Delage and was *préparateur* at the Roscoff Marine Biological Station during 1905–14. During the First World War he served in the Zouaves and was twice mentioned in dispatches. His only son, Claude, was killed in the Second World War, in the French aviation service. Vlès was a biologist with wide and original interests. He started as a zoologist, became more and more attracted to the physical chemistry of the cell, and eventually applied his knowledge to problems of human pathology. In 1921 he founded the *Archives de Physique Biologique*, and edited this journal until his death. He was one of the first to make use of cinematography in microscopy, in an investigation of the cleavage of the sea urchin egg in 1911.

Many of Vlès' researches were in the field of spectroscopy, and through this I came to know him and appreciate his human and scientific qualities when working in his laboratory at Strasbourg on the spectroscopy of chlorocruorin. Vlès was very much *le maître* to his pupils, who had an immense admiration and affection for him. He made for himself a special place in French biology which will be difficult to fill.

H. MUNRO FOX

WE regret to announce the following deaths:

Dr. I. Seymour A. Hadwen, formerly director of pathology and bacteriology at the Ontario Research Foundation, known for his work on animal pathology.

Prof. H. S. Jennings, emeritus professor of zoology in Johns Hopkins University.

Dr. S. A. Monckton Copeman, F.R.S., an authority on vaccination, on April 11, aged eighty-five.

NEWS and VIEWS

Dr. Robert Broom, F.R.S.

The election of Dr. Robert Broom as an honorary fellow of the Royal Society of South Africa is a recognition of a long life devoted to scientific work. As a student of medicine in Glasgow, Dr. Broom became fascinated by the problem of the ancestry of mammals, and on qualification migrated to New South Wales in order to work on the comparative anatomy and embryology of monotremes and marsupials while earning his living as a general practitioner. The Australian scientific world discovered his existence when a paper on the Organ of Jacobson arrived at the Linnean Society from an unknown man in the bush, to be followed by others. But during a visit to England, Broom saw some of the fossil reptiles recently brought from South Africa by Prof. H. G. Seeley, and realizing immediately that they presented a novel and direct approach to his problem of mammalian ancestry, sailed for South Africa instead of returning to Australia. There in a very few years he revolutionized our knowledge of the fossil reptiles of the Karroo, showed in broad outline how they were related to one another, and introduced a zonal subdivision of the rocks in which they were found which has proved to be applicable in Russia and China as in Central Africa. In 1910 Broom visited New York and there discovered that the Pelycosaurs from the Texan Permian were closely related to the Deinocephalia, the most primitive group of the African mammal-like reptiles. His paper on this subject established this point once for all, and has ever since formed a point of departure from which all more recent work on the classification and evolution of reptiles has proceeded.

This early work of Broom's is remarkable because in it he used his fossils for the solution of specific problems of morphology, and thus introduced a new point of view into vertebrate palæontology. But while actively working on Karroo fossils and for the greater part of his life remaining in medical practice, Broom found time to investigate the poor fragments of fossil mammals found in Pleistocene deposits in South Africa, describing many of them and showing that an extinct Quaternary fauna had existed in that land. When Prof. R. A. Dart discovered the skull of *Australopithecus*, Broom began an examination of the numerous 'bone caves' which exist in South Africa and soon found two new genera of allied giant apes. His view on the significance of these forms is fully set out in a recently published monograph (see *Nature*, June 29, 1946, p. 863), in which he shows that the three form a special sub-family of giant apes, differing in very many ways from those which still live, and that in all these ways they resemble man. They are, in fact, the most man-like in structure of all the primates; and there is some indication that, unlike the forest-dwelling gorillas and orangs, they lived in a dry country not unlike South Africa to-day. The latest discovery is described by Dr. Broom on p. 602 of this issue. This work is the most important contribution to the problem of human ancestry published for many years, and is a fitting climax to Dr. Broom's fifty years work.

Boyle Medal of the Royal Dublin Society: Prof. J. H. J. Poole

The Council of the Royal Dublin Society, on the recommendation of its Committee of Science, has awarded the Society's Boyle Medal to Prof. J. H. J. Poole, professor of geophysics in the University of Dublin, for his distinguished contributions to geophysics, many of which have been published in the Society's *Proceedings*. His early work, much of it in conjunction with the late Prof. J. Joly, was largely concerned with the measurement of the radioactivity of the earth's crust. His more recent papers include discussions of the earth's thermal history, the evolution of the atmosphere, and the possibility of initiating thermo-nuclear reactions under terrestrial conditions.

Building Research Division, National Research Council, Canada

Prof. R. F. Legget, associate professor of civil engineering, municipal and structural division, University of Toronto, has been appointed head of the Division of Building Research under the National Research Council, Canada. The new Division of Building Research will work very closely with the Central Mortgage and Housing Corporation, and will provide the required scientific data for an adequate programme in all fields of construction, including building materials, types of construction, lay-out, and all other essential features. Prof. Legget had extensive experience in construction engineering in Great Britain and on the Continent before going to Canada in 1929 to join the Construction Division of the Power Corporation of Canada. He later became a member of the staff of the University of Toronto. Born in Liverpool in 1904, he was trained at the University of Liverpool.

Marconi Jubilee and Exhibition

Fifty years ago, in 1897, Signor Guglielmo Marconi gave the first demonstration of wireless telegraphy which was recognized by the Postmaster-General as establishing a new means of communication. At that time, Marconi was twenty-three years old, and he had come to Great Britain in the previous year from Bologna, where he had conceived the idea of using the so-called Hertzian waves for the development of a means of signalling without a wire connexion between the sending and receiving stations. Sir William Preece, who was the engineer-in-chief of the Post Office at the time, had been conducting experiments with a wireless circuit using magnetic induction between large loops; and it was due to Preece's interest and encouragement that Marconi was able to develop his experiments, leading to a successful demonstration across the Bristol Channel. It was in commemoration of this demonstration that a jubilee dinner was held at Guildhall on April 21 under the presidency of Lord Listowel, the retiring Postmaster-General.

In further celebration of these achievements of fifty years ago, the Marconi Company arranged a Jubilee Exhibition at Queen's House, Kingsway London, during April 23–May 2. The Company was originally formed as the Wireless Telegraph and Signa Company soon after the demonstration mentioned above. A few years later, this became Marconi's Wireless Telegraph Co., Ltd., and, with the associated Marconi International Marine Communication Co. Ltd., has recently been incorporated in the English Electric Group of Companies. The exhibition comprised a photographic and pictorial display together with a collection of apparatus and equipment developed for various applications; this collection ranged from a replica of Marconi's original transmitter as used in 1897 to the marine type of rotating radar aerial with P.P.I. display which is being fitted to merchant ships to-day. Special attention was also given to the modern applications of radio waves, including high-speed communication and printing equipment, direction-finding apparatus, and mobile telegraph and telephone equipment for police and other purposes. In view of the present widespread use of radio waves for communication, broadcasting, television, navigational aids, surgical and industrial purposes, it is interesting to have this reminder that the whole of the technique in these fields has been developed during the past fifty years.

Amalgamation of the Institutions of Mechanical Engineers and Automobile Engineers

An important and heartening announcement is that of the amalgamation of the Institution of Mechanical Engineers and of the Institution of Automobile Engineers, which took place on April 13. During the past fifty years and more, the individual energies of engineers have been dissipated and their corporate authority has been lessened by the multiplicity of engineering institutions which grew up to satisfy the needs of specialist branches of the profession. Though many of these younger institutions have done excellent work in furthering the development of particular sections of engineering, which it was felt at the time of their foundation were neglected by the senior institutions, there is no doubt that the engineering profession has been split by conflicting allegiances; and that it has been more difficult for engineers to speak with one voice on important issues. The Institution of Mechanical Engineers was founded in 1847, so that the amalgamation occurs most happily in the year that the Institution celebrates its centenary. The Institution of Automobile Engineers is forty-one years old.

Under the terms of the agreement to amalgamate, the Institution of Automobile Engineers will surrender its charter and dissolve the Institution. Its corporate members will become corporate members of the Institution of Mechanical Engineers, being placed as the first members on the register of a newly formed Automobile Division. Whatever the advantages of the welding together of the combined membership—and they are great—it has clearly been made possible only by the generous and broad view taken, in the first place, by those holding office in the Institutions. The amalgamation augurs well for the future of mechanical engineering, and it is to be hoped that other institutions will not be slow to follow the example.

Jubilee of the Electron

April 30 marked the fiftieth anniversary of the announcement by J. J. Thomson, at an evening discourse at the Royal Institution, of the existence of the electron, and the first approximate estimate of its mass. Cathode rays had been extensively studied in many laboratories for the previous fifteen or twenty years, and their peculiar properties had been widely discussed. It was Thomson's genius which enabled him to unravel the confusing and almost contradictory clues which the experiments afforded as to the nature of the phenomenon, to grasp what was important and what was secondary in the evidence, and to make the final experiment which demonstrated beyond all reasonable doubt that the cathode rays consisted of negatively charged particles, all alike, and all much smaller than the smallest particle hitherto known to science, the atom of hydrogen. The Institute of Physics and the Physical Society, in collaboration with the Institution of Electrical Engineers, is arranging to mark this jubilee by a series of lectures and other functions in London on September 25–26 next; an exhibition demonstrating the great influence this discovery in pure physics has had on the life of the community will be opened at the Science Museum, London, on September 26 and will remain open for about three months.

Heredity

The importance of an international forum of publication in science is not likely to be underestimated by readers of *Nature*. In many branches of science the responsibility was undertaken before the War by journals published in Germany and, to a less extent, in Italy and Japan. Their sudden removal by war was not so seriously felt at the time, owing to the temporary reduction of fundamental research, but it has now raised a serious problem. The position of genetics in this regard is a special one. This science is not only rapidly advancing but it is also rapidly broadening its scope. Indeed it is beginning to cover every aspect of biology and every form of life. It is beginning to weave the threads of many different sciences and techniques into a single pattern. Darwinism and biometry, Mendelism and cytology are being joined together, and the needs of medicine and agriculture are being met by the establishment of a single fundamental discipline. But the work that is necessary to accomplish this task is scattered over the whole world and is developing different characters in different countries.

In these circumstances an explicitly international journal of genetics is bound to serve a useful purpose. Dr. C. D. Darlington and Prof. R. A. Fisher are founding such a journal in collaboration with a group of distinguished foreign geneticists. It will be known as *Heredity* and will be published by Messrs. Oliver and Boyd. The articles promised for the first volume (of which Part 1 is now due to appear) include contributions from a dozen different countries. They cover, if not the whole range of genetics, at least a large part of it. Of outstanding interest perhaps is a bibliography of genetics articles published in Germany and Italy during the War and a summary of British work for the same period. The development of this journal will be watched with keen interest throughout the scientific world.

Whitworth Scholarship Regulations

New regulations for the Whitworth Scholarships which the Minister of Education will offer for competition in 1948 have been published (H.M. Stationery Office. 3*d*. net). The following awards will be available: two Whitworth Senior Scholarships, tenable for two years, valued at £325 each; five Whitworth Scholarships, tenable for three years, minimum value £200 each; ten prizes valued at £20 each, to unsuccessful competitors for Whitworth scholarships whose work deserves recognition, the money to be spent in the furtherance of the competitor's engineering education. The conditions governing the Whitworth Scholarships have now been altered in two main respects. Candidates must have completed twenty-four months of works training instead of thirty months as hitherto, and entry is still limited to part-time students. The Ministry of Education Science Scholarships examinations in engineering will continue to be used for the purpose of making the awards, but the conditions for these have also been amended. Candidates will be required to reach a certain minimum standard in the two qualifying papers of mathematics and applied mechanics, and will also be required to take three scholarship papers, chosen from a number of alternatives. Workshop technology is introduced for the first time as one of these subjects. The entries for the Whitworth Senior Scholarships have, in the past, been governed by the same conditions as for the Whitworth Scholarships. Many university students could not qualify, however, because of the practical training conditions; this requirement has now been omitted, but a successful candidate will have to spend at least one year in a works on taking up a Senior Scholarship. No formal examination will be held, but a candidate must submit a thesis on one of a number of specified subjects.

Collection of Czechoslovak Chemical Communications

FOUNDED in 1929 for the purpose of publishing in French or English the results of researches conducted by Czechoslovak chemists, the *Collection of Czechoslovak Chemical Communications*, which ceased publication in 1939, has now been resumed under the same editorial direction of Profs. J. Heyrovský and E. Votoček. The first issue for 1947 contains an appreciation of the scientific work of Prof. Antonín Šimek, who was executed by the Germans during the War (see *Nature*, 152, 69; 1943). About half this issue is taken up with the recent polarographic researches of Heyrovský and his co-workers, who have studied certain phenomena at the dropping (and streaming) mercury cathode both polarographically and oscillographically. These open up an important new field in the study of electrode interfaces. From the laboratory of Prof. Votoček there is a paper on the synthesis of the remaining mono-methyl-azulene. The authors, F. Šorm and J. Fajkoš, started with *cis*- and *trans*-cyclopentane-dipropionic-(1, 2)-acids, and by a series of interesting steps arrived at the trinitrobenzene compound of 6-methyl-azulene. This was decomposed chromatographically over an aluminium hydroxide column. Finally, methyl-azulene was crystallized as a purple-blue solid, m.p. 83° C. Another contribution to organic chemistry is by Dr. R. Lukeš, who describes N-methyl-1.2.5.6.-tetrahydropyridine. The subscription for the journal has been raised to £2 or 400 Czechoslovak crowns.

Royal Institute of Chemistry: Anniversary Meeting

THE sixty-ninth annual general meeting of the Royal Institute of Chemistry was held on April 18. In presenting the report of the Council for 1946, the president, Mr. G. Roche Lynch, referred to some of the principal developments in the work of the Institute. Closer contact with the four Dominion chemical institutes had been established through a meeting with their representatives which was held in London last June. The first edition of a "Directory of Independent Consultants in Chemistry and Related Subjects" was issued during the year. Highly successful courses in "Oils and Fats" and "Spectroscopy", arranged at the University of Liverpool by the Liverpool and North Western Section of the Institute, represented the first of the series of courses, conferences and symposia to be held under the auspices of the Institute as such. Through the generosity of Dr. David Spence, a series of Henderson Memorial Lectures had been established as a tribute to the memory of the late Prof. G. G. Henderson, a past president of the Institute; and the first lecture in this series was delivered by Sir Ian Heilbron. By agreement between the Ministry of Education and the Institute, the scheme for national certificates has been amended so as to provide separate certificates in chemistry and in applied chemistry. During 1946, the membership of the Institute (fellows and associates) passed the 10,000 mark. Mr. G. Roche Lynch was elected president for 1947–48.

"Specpure" and "H.S." Elements and Chemicals

CERTAIN metals and chemicals of the very highest purity for spectrographic work were first supplied on a small scale by Messrs. Adam Hilger, Ltd., in 1923, and their "H.S." and "Specpure" chemicals are now well known. With increased demand for more substances and greater quantities, it has been found desirable to transfer the preparation of these carefully standardized substances to Messrs. Johnson, Matthey and Co. The range of available chemicals, to be marketed as "H.S.", "Specpure" or "Matthey" standards, has been considerably extended; some sixty-eight elements are listed, either as metals, oxides or salts, in Johnson and Matthey's latest catalogue. They are all of the highest possible purity, and their manufacture is controlled spectrographically.

International Geological Congress, 1948

THE 18th Session of the International Geological Congress, originally planned for 1940 and postponed on the outbreak of war, is to be held in Great Britain in 1948, on the invitation of the Geological Society of London. A third circular containing preliminary arrangements for the session has been issued. Meetings will take place in London during August 25–September 1, 1948, and the following subjects have been provisionally listed for discussion: (1) Problems of Geochemistry; (2) Metasomatic Processes in Metamorphism; (3) Rhythm in Sedimentation; (4) Geological Results of Applied Geophysics; (5) Geology of Iron-Ore Deposits; (6) Geology of Petroleum; (7) Geology, Paragenesis and Reserves of the Ores of Lead and Zinc; (8) Geology of Sea and Ocean Floors; (9) Pliocene–Pleistocene Boundary; (10) Faunal and Floral Facies and Zonal Correlation; (11) Correlation of Continental Vertebrate-bearing Rocks; (12) Earth Movements and Organic Evolution. Geological excursions covering most of the British Isles, which are planned to take place between August 7 and September 18, form part of the Congress programme. They include sixteen long excursions (7–16 days) before the meetings in London, and sixteen of similar length after the meetings. There will also be daily excursions, centred on London between August 22 and September 3. Sir Thomas Holland is president of the General Organising Committee and president-designate of the Congress. The general secretaries are Mr. A. J. Butler and Dr. L Hawkes, and the treasurer is Mr. F. N. Ashcroft. All communications should be addressed to the Genera Secretaries, XVIII Session International Geologica Congress, Geological Survey and Museum, Exhibitio Road, London, S.W.7.

Summer School in Inorganic Micro-Chemistry

Although the advantages of small-scale methods of analysis have led to provision in various British universities and technical colleges for a certain amount of instruction in micro-techniques, it is believed that refresher courses for chemists who have not had recent contact with micro-methods would be of value (see also *Nature*, 156, 588; 1945). Modern micro-methods are essential for attacking certain analytical problems, and in addition selected semi-micro and micro-methods offer advantages over more conventional methods in the teaching of practical chemistry to undergraduates. To provide practical experience in modern small-scale techniques, a summer school has been arranged at Queen's University, Belfast, during June 23–July 5. This course is planned to provide about seventy-five hours practical work. Particulars can be obtained from the secretary of the University.

Summer Course on Rheology

A short summer course on rheology will be given at the Polytechnic, Regent Street, London, W.1, during July 28–31. It is specially designed for those engaged on rheological problems in industry, and the lectures will deal with general rheology, as well as with certain special applications. The lecturers will include Dr. G. W. Scott Blair and Dr. L. R. G. Treloar. Particulars may be obtained from Dr. J. Topping, Polytechnic, Regent Street, London, W.1.

Place of Universities in the Community

The Division for Social and International Relations of Science of the British Association has arranged a conference on "The Place of Universities in the Community", to be held in the University of Manchester on May 10. The speakers will include: Lord Simon of Wythenshawe, Sir Henry Dale, Prof. J. D. Bernal, Prof. P. M. S. Blackett and Prof. M. Polanyi. Opportunity will be provided for other contributions to the discussion. Admission will be free, without tickets. Further particulars can be obtained from the secretary of the British Association.

Travelling Atomic Energy Exhibition

A travelling train exhibition is being organised by the Atomic Scientists' Association with the co-operation of the Ministry of Supply to illustrate the facts about atomic energy and its industrial applications in a simple and attractive manner. The train will visit fifty-five of the principal towns of Great Britain and take a year to complete the course. The information will be conveyed by charts, diagrams and photographs. It is also planned to show some simple experiments as well. At the various stopping places it is hoped to organise 'Atomic Weeks', which will include public discussions, in order to focus attention on the significance of the industrial revolution which will be brought about by the harnessing of atomic energy.

Comets

Comet Grigg–Skjellerup (1947*a*). E. L. Johnson, Johannesburg, recovered this comet on March 11, about 2° from the place predicted by F. R. Cripps in the "Handbook of the British Astronomical Association, 1947". Its magnitude was 11, but it will be a little brighter in May. An ephemeris is given below.

1947	0h R.A.	Dec.	r	ρ	Mag.
May 7	22h 38·1m	+17° 20′			
15	24·5	21 29	0·948	0·357	10·1
23	16·6	24 29			
31	10·4	+26 47	1·071	0·467	11·2

Two other comets have been discovered but are faint objects. Ephemerides are given for the month of May.

Comet Jones (1946*h*).

1947	0h R.A.	Dec.	r	ρ	Mag.
May 7	20h 08·6m	+34° 26′			
15	07·2	36 58	3·033	2·803	11·8
23	04·0	39 17			
31	19 59·1	+41 20	3·208	2·870	12·1

Comet Bester (1946*k*).

1947	0h R.A.	Dec.	r	ρ	Mag.
May 7	1h 43·7m	+25° 35′			
15	46·8	27 59	2·631	3·521	12·2
23	49·6	30 27			
31	51·9	+32 59	2·705	3·457	12·3

Announcements

Prof. P. M. S. Blackett, Langworthy professor of physics in the University of Manchester, will deliver a lecture on "The Magnetic Field of Massive Rotating Bodies" at a meeting of the Royal Society on May 15 at 4.30 p.m.

Prof. E. D. Adrian, professor of physiology in the University of Cambridge, will deliver the Alexander Pedler Lecture under the auspices of the British Association on May 14 at 5.30 p.m. The Lecture will be given in the Royal Institution, and Prof. Adrian will speak on "The Sense of Smell". Tickets are available on application to the secretary of the British Association.

In connexion with the Pasteur Exhibition at the Science Museum, two public lectures will be given in the lecture theatre of the Museum on Pasteur and his work: Prof. J. D. Bernal will speak on "Pasteur, the Crystallographer" on May 14 at 5 p.m.; Dr. E. Chain on "Pasteur, the Biochemist" on May 19, also at 5 p.m.

Messrs. Kodak Ltd., Wealdstone, Harrow, Middlesex, have arranged an exhibition of applied photography to be held at Australia House, Strand, London, during May 7–16, 10 a.m.–5.30 p.m. (except May 10 and 11). The exhibition will be opened by Prof. E. N. da C. Andrade on May 6 at 11 a.m.

Dr. F. D. Ommanney has been appointed by the Colonial Office to be marine biologist, Mauritius–Seychelles Fishery Survey.

The Twelfth International Congress of Psychology, postponed from 1940, will be held in Edinburgh during July 23–29, 1948. Prof. James Drever is president of the Committee of Organisation, and Prof. Godfrey Thomson, Moray House, Edinburgh, 8, is general secretary. It will facilitate arrangements if those likely to attend will communicate with the general secretary.

At the annual general meeting of the Gas Research Board, Viscount Falmouth was re-elected president for 1947–48, and Dr. Harold Hollings, controller of research of the Gas Light and Coke Co., has been appointed chairman in succession to Dr. E. V. Evans, who has resigned.

Erratum. In the communication "Plasma Cellular Reaction and its Relation to the Formation of Antibodies *in vitro*" in *Nature* of April 12, p. 499, the abbreviation 'pcs' used by the author in the heading of col. 6 of Table 1 was wrongly interpreted as 'plasma cells'; it should read 'pieces'.

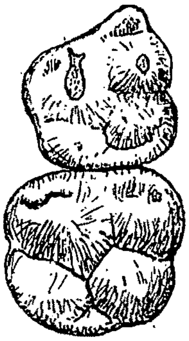
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Upper Milk Molars of the Ape-man, *Plesianthropus*

A FEW days ago I discovered at Sterkfontein remains of two new skulls of *Plesianthropus transvaalensis*. The specimens were found within a few feet of the spot where the type was discovered. One of the specimens is the crushed snout of apparently a young male with some beautiful teeth. The other is a fragment of the snout of a young child of about three years. This latter specimen has the milk molars shown in almost perfect condition.

Comparatively little study has been made of the milk molars of the different races of man; little on the milk molars of the living apes, and scarcely anything is known of the milk molars of the fossil apes.



LEFT MILK UPPER 1ST AND 2ND PREMOLARS OF *Plesianthropus transvaalensis* BROOM. TWICE NATURAL SIZE

The accompanying figure shows the two upper milk molars of *Plesianthropus*. If these be compared with figures I have given in the book on "The South African Fossil Ape-men" of the corresponding teeth in the Taungs ape-man *Australopithecus* and in a Bush-child, it will be seen that there is fairly close agreement. In fact, the teeth are practically identical in structure with those of the Bush-child.

In the 1st milk premolar, attention may be directed to the well-developed anterior outer accessory cusp, which is practically a human character, and to the presence of a Carabelli pit on the anterior inner main cusp.

In the 2nd milk molar there is not only a well-marked Carabelli groove, but also a well-developed Carabelli cusp. In the Bush-child tooth which I figured there is also a well-marked Carabelli cusp.

The Carabelli cusps on the inner and anterior side of the inner and anterior main cusp is a human character rarely, if ever, seen in apes, though what may be the homologue occurs in some lemurs; and the cingulum seen in *Proconsul* and some other early apes may be the factor that determines the Carabelli cusp.

The presence of a distinct Carabelli cusp on the 2nd milk premolar of *Plesianthropus* seems to show that this ape-man is very nearly related to man, and not closely related to the living apes.

R. BROOM

Transvaal Museum,
Pretoria.
April 12.

Normal Development of Fertilized Rabbit Ova Stored at Low Temperature for Several Days

WE are indebted to Ivanov[1,2], Walton[3,4], and Hammond[5] for the demonstration that mammalian spermatozoa can be kept at low temperature for some length of time without loss of fertilizing capacity. These observations gave rise to the new technique of artificial insemination in animal breeding, which is widely practised for live-stock improvement.

The viability of rabbit spermatozoa in the female tract following copulation[6] is only about 30 hours. However, rabbit spermatozoa can be kept alive *in vitro* for 96 hours at 10° C.[5], or 168 hours at 15° C.[4]. At body temperature, the maximum survival time *in vitro* is 13 hours[4]. Rabbit ova are capable of fertilization only for 6–9 hours[7,8] after ovulation *in vivo*.

In view of the fact that the life-span of spermatozoa is shorter at body temperature *in vivo* or *in vitro* than at low temperature *in vitro*, and in view of the fact that the delayed implantation of fertilized ova is fairly common in certain mammals (for example, Mustelidæ and Muridæ[9]), it was thought possible that the fertilized ovum could be kept *in vitro* at low temperature for a certain length of time without loss of its capacity for normal development.

Ova of super-ovulated rabbits[10] in the two-blastomere stage were stored in pure rabbit serum at low temperatures for varying lengths of time and then cultured for 24 hours at 37° C. to determine whether normal cleavage would occur. It was found that rapid cooling from 25° to 0° C., or to 5° C., followed by maintenance for 24 hours at the low temperature, was harmful to the subsequent viability of ova. On the other hand, slow cooling (from 25° to 0° C. in 5 hours, or from 25° to 5° C. in 4 hours) was considerably less harmful. However, there is no difference between rapid cooling and slow cooling from 25° to 10° C. These results indicate that the ova are subject to temperature shock upon rapid cooling, but can be acclimatized to lower temperatures by slow cooling. The latter procedure has been demonstrated by Chang and Walton on spermatozoa[11].

The optimal temperature for the survival of ova was found to be 10° C. (see table).

THE VIABILITY OF FERTILIZED RABBIT OVA CULTURED AT 37° C. AFTER PRE-INCUBATION AT LOWER TEMPERATURES

Storage time (hours)	Storage temperature (° C.)	Per cent normal cleavage
24	0	63·4
	5	78·3
	10	82·2
	15	85·5
	25	37·2
72	0	48·1
	5	54·2
	10	58·8
	15	43·1
	25	0
120	0	0
	5	6·3
	10	36·5
	15	0
144	10	23·6
168	10	0

The normal cleaved ova cultured at 37° C. following low-temperature storage were transplanted[8] into the Fallopian tubes of doe rabbits, which had been injected with gonadotrophin 24 hours earlier to induce ovulation. In each instance, 4–15 ova were transplanted to each rabbit. After transplantation of ova stored at 0° C. for 78–102 hours, four litters of one to two young each were delivered. Four litters (2–7 young) were delivered from eight recipient does following transplantation of ova stored at 5° C. for 48–80 hours. Four litters of one to four young were delivered from five recipient does after transplantation of ova stored at 10° C. for 80–101 hours. One litter of one young was obtained from two recipient does after transplantation of ova stored at 15° C. for 72 and 96 hours. All the young born were healthy, normal and genetically true to their real parents.

Finally, five does were transplanted with normal cleaved ova cultured at 37° C. for 24 hours after storage at 10° or at 5° C. for 120–144 hours; one of them gave birth to an abnormally small young at full term. Considering the small litter size in the cases of successful transplantation and the failure of pregnancy after longer times of ova storage, it is evident that the ova which cleave normally in culture are not necessarily sufficiently viable for full development.

This work is still being carried on to determine the efficacy of transplantation, and the detailed results will be published elsewhere. Considering the improbability of multiple birth after super-ovulation[12-21], and the possibility of application of the technique in animal breeding, these findings may open a new field for the full utilization of the germ cells of valuable animals.

The work was carried out in the laboratory of Dr. Gregory Pincus, to whom I am much indebted for advice and encouragement. Thanks are due to the Foundation for Applied Research, San Antonio, Texas, U.S.A., for a grant.

MIN-CHUEH CHANG
Worcester Foundation for Experimental Biology,
Shrewsbury, Massachusetts.
Feb. 25.

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Hyaluronidase in Sea-Urchin Sperm

A SUBSTANCE liquefying the jelly-coat of sea-urchin eggs was first recovered from the sperm of sea-urchins by Hartmann and Schartau[1], who called it 'Androgamone II'. The enzyme nature of this substance was, however, denied[2]; moreover, it was pointed out that hyaluronidase from bull testis does not dissolve the jelly-coat of sea-urchin eggs[3]. On the other hand, an enzyme preparation from *Clostridium oed. mal.* was found to dissolve it[4].

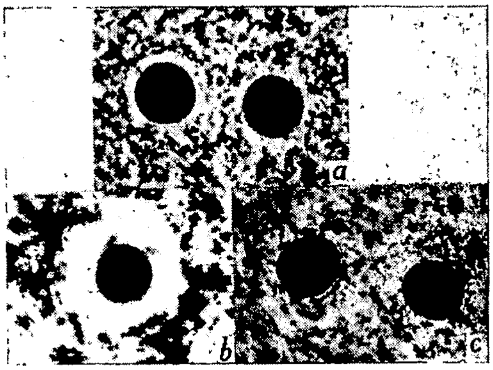

Fig. 1. EGGS OF *Sphærechinus gran.* IN INDIAN INK, IN ORDER TO MAKE THE JELLY-COAT VISIBLE: (*a*) NORMAL EGGS; (*b*) AFTER 3 MIN. ACTION OF A PREPARATION FROM *Arbacia* SPERM; (*c*) AFTER 13 MIN. THE JELLY-COAT IS COMPLETELY DISSOLVED

Recently, McClean and Rowlands[5], Fekete and Duran Reynals[6] and Rowlands[7] stated that hyaluronidase from the sperm of some animals (and from other sources, too) disperses the cumulus cells of mice and rat eggs. We therefore tried to find out whether the liquefying factor from the sea-urchin could be identified with hyaluronidase.

From sperm and testes of *Arbacia lixula* (= *pustulosa* Auct.) and *Sphærechinus gran.*, a substance was obtained which dissolves the jelly-coat of sea-urchin eggs and also lowers the viscosity of a mucin solution.

The preparation was made according to the technique of Claude and Duran Reynals[8]; that is, by extracting the ground material with $N/10$ acetic acid and precipitating with acetone. The precipitate was desiccated *in vacuo*. From 100 gm. of fresh material, 1 gm. of powder was recovered. This powder was dissolved in sea-water (pH *c.* 8) or in 0·85 per cent sodium chloride (pH *c.* 6·8). About 60 per cent of the powder remained undissolved and was removed by centrifuging. The ability of the solution (15 mgm. dry matter in 10 c.c. of solvent) to dissolve the jelly-coat of unfertilized sea-urchin eggs and to lower the viscosity of a mucin solution (in 0·85 per cent sodium chloride, pH *c.* 7) was tested. As a control, a preparation from bull testis and a total extract from heads of leeches was used.

The jelly-coat of unfertilized sea-urchin eggs (*Psammechinus*, *Sphærechinus*, *Arbacia*, *Paracentrotus*) swells as soon as the eggs are placed in the solution (Fig. 1 *b*), and after 10–15 min. it is completely dissolved (Fig. 1 *c*). A similar effect is shown by the extracts from heads of leeches. Preparations from bull testis, on the other hand, fail to dissolve the

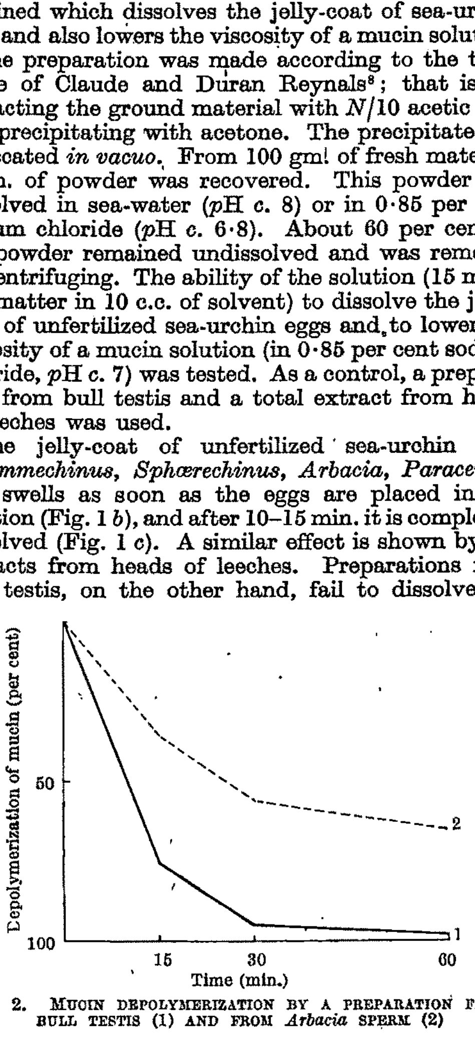

Fig. 2. MUCIN DEPOLYMERIZATION BY A PREPARATION FROM BULL TESTIS (1) AND FROM *Arbacia* SPERM (2)

jelly-coat, which swells only after one hour of incubation. The two preparations also act in different ways when tested on a mucin solution: that from bull testis lowers the viscosity strongly and quickly, whereas that derived from sea-urchin testis acts only very slowly (Fig. 2).

Dialysis and egg water do not inactivate our preparation. Tryptic activity was excluded. The power of the preparation to liquefy the jelly-coat and to depolymerize the mucin disappears on heating at 100° C. for 5 min.

A more detailed account and a discussion of these results will be given elsewhere[9].

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Mutations in *Drosophila* Induced by a Carcinogen

Numerous attempts have been made by several geneticists to induce mutations in *Drosophila* by treating either eggs, larvæ, pupæ or adults with various chemicals. The first unquestionably positive results were obtained by C. Auerbach and J. M. Robson, who induced genetic changes in the sperm of males by exposure to the vapours of various mustards. There is very little doubt that the method of treatment developed by Auerbach and Robson contributed significantly to their success. This method can be used with chemical substances that can be handled as vapours.

For almost two years I have been working on a method that permits the use of chemical substances in solution. *Drosophila* males are kept in an atmosphere containing a fine ærosol of the solution being tested for mutagenic capacity. So far twenty-one substances have been investigated. An aqueous ærosol of nitrogen mustard (*HN*2) was the first to give positive results[1], indicating that the method is effective. Experiments are now in progress to test the mutagenic potency of several carcinogens, applied as ærosols of oil solutions. The first to be used was 1,2,5,6-dibenzanthracene. It gave positive results. Sperm of treated males was tested for X-chromosome lethals by the standard *ClB* method, and a considerable increase in the proportion of lethal mutations was observed.

	Chromosomes tested	Lethals	Per cent
Controls	7,755	3	0·04
Tests of 19 substances	47,028	18	0·04
Nitrogen mustard	5,491	90	1·67
1,2,5,6-dibenzanthracene	3,257	29	0·89

All lethals obtained in these experiments are being tested for chromosomal aberrations. The first results indicate that dibenzanthracene induces breaks in chromosomes as well as mutations.

Experiments with several carcinogens are now in progress, to determine if there is any correlation between carcinogenicity and mutagenic capacity in chemicals.

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Selective Mating as a Factor for Speciation in Cichlid Fish of East African Lakes

In most of the modern texts on evolution[1], one of the outstanding proofs of speciation, that is, development of forms separated from one another under normal conditions by their immiscibility, without geographical isolation, is the very high number of species and genera of the Cichlidæ in almost every one of the great lakes in East Africa. This remarkable phenomenon (Woltereck's "*schizotypische Artaufspaltung*") is characteristic only for the Cichlidæ of the East African lakes; other genera of freshwater fish can be represented in the same area also by more than one species, but in no other family is the diversity of types—some of them being specialized to a certain mode of life and nutrition—so well developed as in the Cichlidæ.

A plausible interpretation of this fact is still wanting, because the many factors influencing the rapid tempo of evolution proposed up to this time (existence of predators, small number of individuals occupying a new niche, old age of the lake basin in question, etc.) do not fit all lakes in the same manner and, on the other hand, would be applicable also for fish of other families. So there must exist, with high probability, a special mechanism in the Cichlidæ favouring a splitting-up in smaller groups with preferred mating tendencies *intra se* not found in the other groups.

The Cichlidæ show in varying degrees very characteristic breeding-habits. Where in other fish there is parental care for the brood, generally only one of the parents is involved; in the majority of the cases it is the male that is concerned with defence, aeration, etc., of the eggs and care of the young fish. In the Cichlidæ, however, there are many cases where the two parents co-operate in their care for their brood. (In some of the genera, for example, in the mouthbreeders, only one of the sexes is involved.) Normally the two sexes live in monogamy[2], at least for the time of one brood, lasting from the beginning of nesting to the end of the family life with the fry which begin an independent life only some days or weeks after hatching. It is easily understandable that, by the introduction of a type of monogamy, even if it is only for one breeding period, a factor is involved which acts against panmixia. Furthermore, it is a well-known fact, which has been observed by a great number of fish-breeders, that in the selection of the mate there is a clearly visible preference between two individuals in a larger swarm of fish of the same species of Cichlidæ. The two mates, long before egg-laying begins, choose a certain corner of the aquarium and do not allow other fish to approach it. This fact proves that pair formation is not haphazard, but conditioned by some psychological factor which results in a strengthening of a relative sexual isolation of different pairs or families from one another. At least under aquarium conditions the continuity of the monogamic life of a male with a certain female, even in the time between two breeding periods, is not an exception but the rule in certain South American Cichlidæ.

In this connexion it is interesting to note that the blind cavernicolous Cichlids of south-west Africa are of the mouth-breeding type, where only one of the two sexes is charged with the care for the brood, and not of that 'father *and* mother family' type of family care which seems to have been able to play an important part in the acceleration of species formation *in loco* in the Cichlidæ of the great East African lakes.

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Feeding Mechanism of Water-Bugs

THE suggestion put forward by Walton[1] that the presence of small teeth and chitinous elevations in the pharynx of *Micronecta* indicates that this Hemipteran ingests and masticates particulate food material appears to be true for other families of the Cryptocerata. There exists in many, and probably all, species of Corixidæ a type of feeding mechanism which does not seem to have been recorded. This takes the form of a modification of the cibarial suction pump[2] in such a manner as to produce a pair of chitinous jaws having a structure and position strongly suggesting that they function as organs for the comminution of solid material. It is a mechanism more elaborate in form than that found in *Micronecta*. The whole ventral wall of the cibarial pump consists of a curved chitinous plate having a thickened posterior margin. The anterior border of this plate appears to be folded back and modified into a transverse triangular bar set with rows of minute tooth-like projections. Above this bar and articulating with it at its lateral ends lies a second chitinous bar formed by the thickened dorsal wall of the cibarium and similarly equipped with teeth or rugosities (Fig. 1). The two bars have the appearance of a pair of grinding jaws, and although the musculature of the organ has not been studied in detail, enough has been noted to support this supposition.

Some variation during the life-cycle in the importance of this mechanism for the grinding of food particles may exist, as in early instar nymphs (Fig. 2) the toothed surfaces are distinct, whereas in the imago, while the ventral plate and jaws are more heavily chitinized, the teeth appear to be less pronounced.

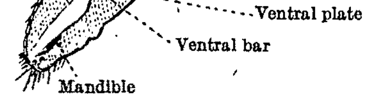

Fig. 1. DIAGRAMMATIC LONGITUDINAL SECTION OF THE HEAD OF *Sigara striata* TO SHOW DISPOSITION OF SCLERITES IN THE CIBARIAL PUMP

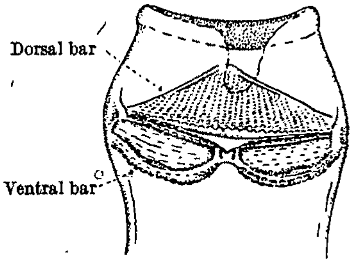

Fig. 2. DORSAL VIEW OF CIBARIAL PUMP IN NYMPH OF *Sigara striata*

The twelve species of *Corixa*, *Sigara*, *Glænocorisa* and *Cymatia* so far examined all show the structure with only minor variations in form between the species. A somewhat similar organ is present also in *Notonecta*, where, however, the teeth are replaced by bristle-like projections; in this family it may serve as a filter.

This is thought to be a type of food ingestion unique in the Hemiptera, and further investigation of the mouth parts and feeding in Corixidæ and Notonectidæ is being made for publication at a later date.

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Effects of High Temperature and Short Days on Vernalization Response of Summer Varieties of Rice

THE effect of high temperature on the acceleration of flowering in a number of varieties of rice has been reported previously[1,2,3,4]. In addition to early flowering, pre-sowing high-temperature treatment results in better resistance to drought conditions[5]. Vernalization by high temperature has practical difficulties. Radicles and plumules emerge from the seed coat during treatment, involving difficulty of transportation. This has been overcome in two varieties of rice noted below by limiting the moisture content of seeds to 30 per cent of fresh weight. Seeds at this moisture content germinated without the radicles and plumules penetrating the seed coat, and gave vernalization response when exposed to high temperature, 35° C., for 10 and 20 days (see table).

As regards the effects of day-length on flowering, a marked contrast between summer (Aus) and winter (Aman) varieties of rice has been noted by us. In previous communications in *Nature*[6,7], acceleration of flowering of winter varieties by short days has been reported by one of us, and this has been confirmed[4]. On the other hand, the effect of short days on summer varieties is different. The following results (see table) show that short days delay flowering and annul the effect of vernalization by high temperature. Pre-sowing high-temperature treatment accelerates flowering; but when this is followed by short-day exposure of seedlings, a reverse effect in the delay in flowering is noticed.

In the light of these findings, Kar's statement[4] that in different varieties of paddy warm temperature associated with short day-length is inducive to earliness, and cold temperature or longer day-lengths produces retardation, needs modification. In the

Summer (Aus) variety of rice	Treatments	No. of days from sowing to flowering	Acceleration (+) or retardation (−) of flowering as compared with control
Charnock	Series I		
	A	113·8	
	B	120·6	− 6·8
	C	109·6	+ 4·2
	D	121·4	− 7·6
	Series II		
	E	110·5	+ 2·5
	F	126·3	−13·3
	G	113·0	
Panbira	Series I		
	A	110·5	
	B	121·8	−11·3
	C	109·9	+ 0·6
	D	122·7	−12·2
	Series II		
	E	99·8	+ 7·8
	F	111·8	− 4·2
	G	107·6	

A, Control; *B*, 8-hour day for 4 weeks; *C*, 35° C. for 10 days; *D*, 35° C. for 10 days plus 8-hour day for 4 weeks; *E*, 35° C. for 20 days; *F*, 35° C. for 20 days plus 8-hour day for 4 weeks; *G*, control.

varieties examined by us, short days did not induce earliness but rather they have a devernalizing effect; also long days do not always retard, but sometimes accelerate, flowering, for the data for two Aus varieties presented in the statement[4] show acceleration by long days. It appears to us that Kar's results indicate that in Aus varieties long days, and in Aman varieties short days, tend towards the acceleration of flowering.

We desire to thank the Indian Council of Agricultural Research, New Delhi, for a grant in aid, and the Department of Botany, University of Calcutta, for laboratory facilities to carry out the investigation.

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Sunflower Stem Cultures for the Detection of Plant Hormones

FRAGMENTS of young stem tissue of *Helianthus annuus* (L.), when cultured on a nutrient medium containing 2 per cent sucrose and mineral salts, are capable of making only a limited amount of growth, chiefly confined to the production of a pad of callus tissue on the cut surface. Such cultures have been shown to respond in various ways to certain plant hormones. Root production results from the addition to the medium of one part per thousand million of such substances as indole acetic, indole butyric or naphthalene acetic acid to the agar on which such stem fragments are cultured. The type of root growth varies with the hormone used[1]. Higher concentrations of these substances cause a characteristic proliferation of the stem tissue. These reactions have already been used to demonstrate the presence of indole acetic acid in commercial penicillin. The crystalline penicillins *G* and *X* were shown to have root-initiating properties by this means, but to differ from indole acetic acid in that they failed to induce the same characteristic cellular proliferation at high concentration[2]. The reactions have also led to the detection of growth-substances in bacteria-free crown gall tissue.

The following method has been used for applying tests. Sunflower plants (var. Russian giant) were grown in pots until the first internode of the plant was fully expanded and the second was on the point of beginning to elongate. Such plants were cut off at the base and removed to the laboratory. By means of sterile forceps the epidermis was carefully stripped from the first internode, which was freed by this means of all external contaminants. The internode was then cut into segments of about 4 mm. in length by means of a sterile scalpel. Each segment was then transferred to an agar slope containing 0·8 per cent agar, 2 per cent sucrose, mineral salts (White's solution) and the substance to be tested. Tests so far have been carried out in 25 mm. × 150 mm. 'Pyrex' tubes containing 20 c.c. of agar. If the amount of material available was limited, it was incorporated into a few millilitres of agar, which was then cut into small blocks and applied to the cut surface of the stem fragment.

The sunflower stem fragments were taken from the upper half only of the internode, as tissue of the lower half tended to produce roots spontaneously. Material to be tested was always applied to the basal end of the fragment. If a root-producing substance had been added to the agar, root production was generally evident in about four days. A two-week period of growth was used when it was desired to detect the influence of a substance on the increase in fresh or dry weight of the fragment. Quantitative estimates of this kind were based on means from at least twenty samples. Histological effects of the unknown substances were also looked for.

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Sex Differences in Colour Vision

IN a previous communication[1], it was shown that women with known colour-blind relatives were significantly more often red-green weak to a slight extent than women taken at random. This carried the implication that red-green blindness must be an incompletely recessive Mendelian character (although sex-linked), because a large proportion of the women with known colour-blind relatives must be heterozygous for that defect. Several later experiments have confirmed that conclusion, essentially the same results being obtained with each new group tested.

Another experiment, carried out on 191 men and 185 women with normal colour vision (but otherwise chosen at random), and 18 women with known colour-blind relatives, has confirmed the same conclusion in a different way. Sensitivities to the differences between red and green and between yellow and blue were measured by the limiting method, using monochromatic colour filters. The subjects tested were then grouped to compare men with women selected at random, and these women in turn with the women who knew of colour-blind relatives. The χ^2-technique showed a higher proportion of women than of men in the random samples, who had more than twice the modal red-green threshold, on a probability-level of less than 0·001, although the modal threshold was the same for both sexes. Similarly, there were more women with twice the modal red-green threshold among those with known colour-blind relatives than among the random sample of women, on a probability-level of less than 0·01. In yellow-blue vision there were no significant differences, either between men and women, or between women at random and women with colour-blind relatives.

If we take Vernon and Straker's figure of 7·31 per cent of red-green defectives among men in Glasgow and the west of Scotland[2], which seems to be a likely proportion compared with other estimates for their frequency among white people[3,4], we may expect about 13·57 per cent of heterozygotes for sex-linked red-green defects among the population of women for the same area. In a sample of 185 women taken at random, we should expect about 25 heterozygotes. In the sample of 185 actually observed, there were 18 more women with twice the modal red-green threshold than there were men in the sample of 191 men, and this does not differ significantly from the 25 heterozygous women expected. This confirms the reliability of the test.

Although there are more major red-green defectives in the population of men than of women, there are more women than men with slight red-green weaknesses. This confirms the view that major red-green defects are sex-linked recessive characters, but incompletely recessive, so that most of the heterozygotes show the character to a slight degree. No sex differences of either kind can be found in yellow-blue vision.

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The Name 'Penicillin'

The recent note "Aspergillin: a Name Misapplied to Several Different Antibiotics", in which Tobie[1] deprecates the practice of assigning names to antibiotics without due consultation of the literature, prompts me to point out, for its historical interest, that even penicillin has not escaped such a duplication in naming. I refer to the use of the name 'penicillin' by Palei and Osuicheva[2] in 1936 to designate a thermostable substance isolated from *Penicillium luteum purpurogenum*, which was unfavourable to the production of citric acid by *Aspergillus niger*. This was seven years after the first use of the term by Fleming[3] in his now famous paper. The oversight is probably due in part to the vagaries of indexing. The name 'penicillin' did not appear in *Chemisches Zentralblatt* until 1934, or in the British abstracts until 1933; it can, however, be found in the 1929 *Chemical Abstracts* and the *Biological Abstracts* for 1930. This serves as another warning against too much reliance on a single abstracting source.

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Emission of Secondary Charged Particles in Fission

It now seems fairly well established that in roughly 1 per cent of all fissions an α-particle is liberated at the moment of fission[1,2]. These secondary α-particles are mostly of small energy (< 2 MeV.), but some are found having energies greater than 20 MeV. It is obviously of interest to discuss the conditions in which such 'secondary' emission may occur.

As concerns the moment of liberation of the α-particle, the direct evidence from the tracks found in loaded emulsions is that an interval of time greater than about 3×10^{-13} sec. does not in general elapse between the instant of fission and the moment of liberation; and the fact that directions of emission at right-angles to the line of separation of the fission fragments are more probable than any others is perhaps even more cogent, though less direct, evidence that the average time interval is much smaller than this. In any case, it is clear that, for α-particles of energy less than 2 MeV. and nuclei of medium atomic number, the half-value period for normal radioactive disintegration is enormously greater than 10^{-12} sec., so that these low-energy particles at least cannot be emitted spontaneously from nuclei which have already settled down to conditions of near-spherical symmetry after the main phenomena of fission have taken place.

We have to discuss, therefore, what is in effect ternary fission, with the third fission fragment assumed to be an α-particle in all cases: and we have to attempt to answer the questions, first, why protons are not as frequently emitted in similar events and, secondly, why ternary fission with α-particle emission is relatively so rare. For almost every other case of fission can plausibly be regarded as a case of ternary (or quaternary) fission, with a 'secondary' neutron as the third (or fourth) particle involved.

One possible approach to an answer might be to assume that since neutrons are in excess in the heavy nucleus in relation to all types of binary fission, the liberation of secondary neutrons is natural, and that when in rare cases protons also become free in the process of division of the compound nucleus, they coalesce with the 'nascent' neutrons to form an α-particle. Such a point of view has the advantage of tackling both questions at once, but the disadvantage that it requires the setting free of protons in pairs.

However, I favour another approach altogether—and it takes first the question why α-emission is relatively so rare. It is assumed that this rarity is connected with the fact that natural α-radioactivity does not appear with medium-heavy elements except within very restricted ranges of Z (atomic number). At present, only one 'naturally' α-active species has been definitely identified ($^{148}_{62}\mathrm{Sm}$), but there is some evidence that ($^{145}_{61}$) may be another, and that a second narrow range of Z ($Z \sim 40$) may be found to include species which are α-unstable[3]. Also, from the practical point of view, the distinction should be made between the 'natural' α-activity of the medium-heavy elements which has remained undiscovered because the characteristic half-value period lies between, say, 10^3 and 10^8 years, or is greater than 10^{14} years or thereabouts; and that which has hitherto escaped detection because of the much more probable positron activity of a species which is 'artificially' produced. Theoretically, of course, such a distinction is of no significance, but it may well reflect one aspect of the situation explaining possible gaps in our present knowledge.

The connexion between natural α-activity and the emission of secondary α-particles in fission is regarded as follows. It is considered that fission is essentially a 'binary' process—the division of the unstable compound nucleus into two fragments—and it is further assumed that any secondary effect occurs between the instant when the two fragments are first separate and the instant when for both the initial energy of deformation has been dissipated. We may hazard a guess that this may happen within a time of the order of 10^{-20} sec. So far as the secondary neutrons are concerned, this point of view is consistent with the observed fact that the energies of the secondary neutrons are on the whole considerably greater than the energies of the so-called delayed neutrons[4,5], an effect to be expected if the former are emitted from fission fragments moving with high velocities whereas the latter are emitted from nuclei which have already been brought to rest[6].

As concerns the emission of secondary α-particles, taking this view of the matter, it is considered that the initial phase of separation of the fragments provides an opportunity for the emission of particles from deformed nuclei in a time which would be altogether too short for normal 'radioactive' disintegration. However, the conditions which must obtain to render such emission at all probable are satisfied only when the primary fission fragment is a nucleus which is α-unstable in its ground-state—or nearly so, for it must be remembered that, in the initial phase considered, the fragment nucleus is not only deformed but also endowed with considerable energy of excitation. Since it appears to be a general rule that the maximum α-instability for Z constant occurs for a small rather than a large value of A (mass number)[7], these conditions for α-emission will be seen to require modes of binary fission in which the 'excess' neutrons are shared very unevenly between the fragment nuclei. That such modes of fission must occur, however, is known from the identification of $^{82}_{35}$Br, $^{86}_{37}$Rb and $^{136}_{55}$Cs as primary fission products[8]. In the very rare modes of fission (relative probabilities 10^{-7}–10^{-4}) in which these species are produced, the disparity in respect of neutron excess in the fragments is extreme: neglecting secondary neutron emission, it would appear to be 1 : 15, 1 : 17 and 3 : 15, in the three cases in question. However, in these cases the fragment nuclei are of odd atomic number; for division into fragments of even atomic number, the total neutron excess would be considerably smaller. For fragment nuclei of charge numbers 40 (Zr) and 52 (Te) or 60 (Nd) and 32 (Ge), for example, the masses of the stable isotopes are such that a total excess of 10 neutrons, only, has to be disposed of by sharing between the fragments and by secondary emission in each case. If, therefore, we accept the narrow ranges of atomic number around $Z \sim 40$ and $Z \sim 60$ as ranges of possible α-instability, it would appear reasonable, on the basis of present knowledge of the dependence of fission yield upon mass number[8], and of the general point of view outlined above, to attribute the more abundant secondary α-particles of low energy to emission from fragment nuclei belonging to the lower range of Z ($Z \sim 40$), and the less abundant but more energetic secondary α-particles to emission from nuclei having $Z \sim 60$.

It might be remarked that since the above was written, I have noticed the announcement[9] of the release of a preliminary American report by Farwell, Segrè and Wiegand dealing with the long-range secondary α-particles. This report does not appear as yet to be available in Great Britain. A publication by Demers[10] has also come to hand.

Finally, thanks should be recorded to Messrs. Green and Livesey for their kindness in communicating their results before publication.

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Department of Natural Philosophy,
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Spontaneous Fluctuations of Current in a Photo-Electric Cell

DATA on the fundamental electrical Brownian movement arising in a high-vacuum photo-cell appear to us to be rather scanty. In the saturated condition, on the plausible assumption that all the emitted electrons proceed to the anode randomly and independently, one might expect the familiar Schottky formula[1] to be obeyed by the current fluctuations, namely:

$$\overline{(i - I)^2} = 2eI\Delta f, \quad . \quad . \quad . \quad (1)$$

where i is the instantaneous current, I is the mean current, Δf the band-width of the measuring instrument.

B. A. Kingsbury[2] reports some measurements giving a value of $\overline{(i - I)^2}$ 25 per cent higher than the theoretical prediction. This work may well have been marred by 'flicker effect'[3,4]. W. A. Harris[5] states baldly that equation (1) will be fulfilled, without reference to experimental data.

In the space-charge limited region where only a portion of the emitted electrons reaches the anode, formula (1) will, in analogy with the well-known facts about the 'shot effect' in thermionic valves, be replaced by

$$\overline{(i - I)^2} = 2eI\Gamma^2\Delta f, \quad . \quad . \quad . \quad (2)$$

where the factor $\Gamma^2 < 1$ is usually termed the 'space-charge reduction factor'. As the space-charge reduction effect must vanish in the 'retarding field' region for very small currents, $\Gamma^2 = 1$ should hold in the latter case and in the saturation region (according to (1)), and it should have a minimum value somewhere in the space-charge region.

These predictions are verified by the results of an investigation on the shot effect in photo-electric cells which is being carried out by one of us (D. K. C. McD.). Fig. 1, representing the dependence of Γ^2 on I in the saturation region, shows clearly that $\Gamma^2 \rightarrow 1$ for the saturation condition within the limits of experimental error. Fig. 2, referring to the region of very small currents with considerable space-charge limitation, shows that Γ^2 indeed increases with decreasing current within this region, and tends towards unity for very small currents.

On the basis of measurements of the spectral response of the type of photo-cell used in these experiments, and assuming a black-body intensity

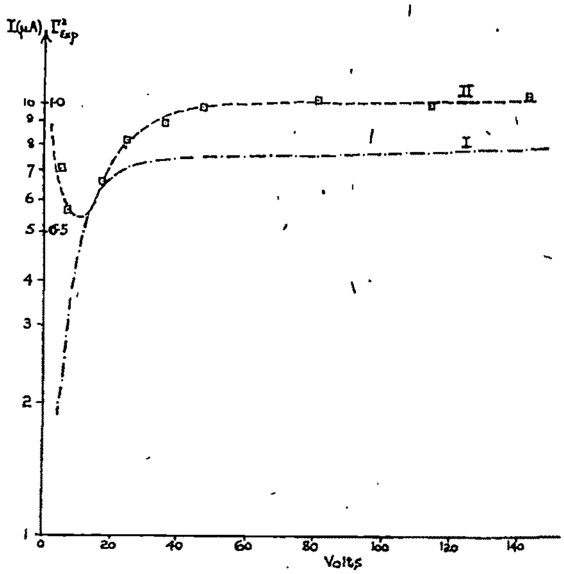

Fig. 1. CHARACTERISTIC OF THE PHOTO-CELL (CURVE I, LEFT-HAND SCALE) AND SPACE-CHARGE REDUCTION FACTOR Γ^2 OF THE SHOT EFFECT (CURVE II, RIGHT-HAND SCALE) AS A FUNCTION OF ANODE VOLTAGE

distribution in the spectrum of the illuminating incandescent lamp, one of us (R. F.) has shown that the energy distribution of the photo-electrons is roughly 'Maxwellian', corresponding to a 'temperature' of about 2,000° K., which is lower than the filament temperature of the lamp, as one might expect.

Using the theory of space-charge-reduced noise developed by D. O. North[6], the electron 'fluctuation temperature' was estimated from the experimental data for Γ^2. Extrapolation to zero current ($\Gamma^2 = 1$) gives a temperature $\sim 3,000°$ K. As this shows agreement in order of magnitude with the 'electronic temperature' estimated above from quite different observations, we may thus reasonably conclude that the usual shot effect theory is valid for the saturation and 'retarding-field' regions.

In the intermediate region, however, the apparent fluctuation temperature is found to vary, increasing with current I; hence North's theory is not directly applicable here.

The most probable explanation lies in the fact that the whole of the emitting surface is not uniformly illuminated; the behaviour will thus be analogous to that of a thermionic valve with part of the cathode at a temperature lower than the rest. Therefore, in this region the observed Γ^2 would be greater than the anticipated value; agreement with theory can thus only be expected in the two extreme regions.

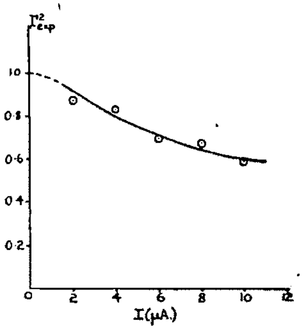

Fig. 2. SPACE-CHARGE REDUCTION FACTOR AS A FUNCTION OF CURRENT (UNDER STRONG ILLUMINATION) IN THE REGION OF EXTREME SPACE-CHARGE LIMITATION

We hope to present a fuller treatment at a future date, and one of us (D. K. C. McD.) has commenced work on measurements of fluctuations using monochromatic radiation and low temperature for the cell.

The assistance of the General Electric Co., Ltd., Wembley, in supplying the photo-cells for this investigation is gratefully acknowledged.

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[1] Schottky, W., *Ann. Phys.*, **57**, 541 (1918).
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[6] North, D. O., *et. al.*, *R.C.A. Rev.*, **4**, 5 (1941).

Identification by X-Rays of Interface Compounds on 'Oxide' Cathodes

A RECENT paper by Fineman and Eisenstein[1] has presented interesting observations concerning the interfacial films formed between coating and metal core material on alkaline earth oxide-coated cathodes. Nickel alloys containing impurity elements such as magnesium, aluminium or silicon (or like elements) are commonly employed for these cathodes, and it has been accepted for many years that the process of activation is facilitated by the presence of one or other of the above impurities[2]. Chemical reaction with the alkaline earth oxide at elevated temperatures frees barium ions which are required for the development of the thermionic emission.

The detection and identification of the interfacial reaction products, if such be formed, are of importance from several points of view. For one thing the detection of the interfacial film reveals that chemical reaction does occur, and the nature of the compound formed shows what constituents of coating and core metal take part in the reaction. For another, the identification of the film will enable measurements of resistivity to be made, a physical property which is regarded as playing a considerable part in the behaviour of 'oxide' cathodes. This is to mention but two of the factors which make studies of the interface of these cathodes of interest.

The technique of X-ray analysis has been used by Fineman and Eisenstein to examine the 'oxide' cathode 'interfaces'. This method has also been employed in these Laboratories with successful results. A reference to an identification of the interface for a base metal consisting of nickel alloyed with a small percentage of aluminium was made in a paper to the Royal Society of Arts in 1940[3]. Because of the recent rise of interest in this feature of 'oxide' cathodes, it has been thought worth while to summarize the results so far obtained.

A variety of specimens has been studied, both from experimental diodes and from more formal thermionic devices, and three principal base metals have been included, namely, nickel containing aluminium, silicon and titanium respectively. The 'oxide' coating was invariably formed from a barium–strontium carbonate solid solution of the conventional type, in which barium and strontium carbonates were present in equimolecular proportions. After vacuum processing and activation of the cathodes, the thermionic devices were opened to the atmosphere, and then the coatings scraped away so as to expose the interface at the base metal. No special precautions have been taken to prevent reaction of the interface compound with the atmosphere.

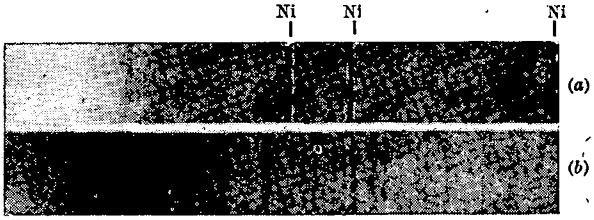
X-ray examination was carried out in most instances by glancing-angle reflexion technique, using copper $K\alpha$ radiation and a circular camera of 19 cm. diameter. In one or two instances the interfacial film was thick enough for filings to be made, but X-ray analyses of such specimens did not yield results differing in any significant respect from that obtained by the surface reflexion technique.

The results are presented in tabulated form below:

Base-metal	X-ray analysis	Standard of comparison made from:
Nickel with 2 per cent aluminium	Barium aluminate, $BaO.Al_2O_3$	Equimolecular proportions of $BaCO_3$ and Al_2O_3 heated to 1,200° C. in air
Nickel with 0·4 per cent silicon	Barium orthosilicate, Ba_2SiO_4*	Mixture of $BaCO_3$ and SiO_2 (finely ground flint) in molecular ratio 2 : 1 heated to 1,300° C. in air
Nickel with 0·23 per cent titanium	Barium orthotitanate, Ba_2TiO_4	Mixture of $BaCO_3$ and TiO_2 in molecular ratio 2 : 1 heated to 1,300° C. in air.

* In Fineman and Eisenstein's paper the interface compound is stated to be "$BaSiO_3$"; but after correspondence, they agree with the results reported here.

The accompanying photograph illustrates the X-ray identification of barium orthotitanate as the interface compound on an 'oxide' cathode in which a nickel–titanium alloy was the base metal.



PARTS OF X-RAY DIFFRACTION PATTERNS (19-CM. CAMERA, COPPER $K\alpha$ RADIATION) OF (a) INTERFACE OF 'OXIDE' CATHODE WITH NICKEL–TITANIUM BASE METAL; (b) PURE BARIUM TITANATE

It is noteworthy that only barium compounds appear to be formed. There is no evidence that any solid solution of an isomorphous strontium compound occurs. This result is also obtained by Fineman and Eisenstein. It is known that isomorphous replacement of barium by strontium can occur with the orthosilicates and orthotitanates prepared for comparison purposes.

Another interesting crystallographic feature is that barium orthotitanate and barium orthosilicate appear to be structurally isomorphous. This is shown by the very close similarity in their Debye–Scherrer powder photographs. Of the two compounds the titanate has the larger lattice parameters. It is not known whether this crystallographic similarity has any significance so far as the thermionic behaviour is concerned.

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[1] Fineman, A., and Eisenstein, A., *J. Appl. Phys.*, **17**, 663 (1946).

[2] Benjamin, M., *Phil. Mag.*, **20**, 1 (1935).

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Crystal Structure of Co[Hg(CNS)₄]

AN X-ray investigation of $Co[Hg(CNS)_4]$ was undertaken in conjunction with work on similar compounds to determine the co-ordination of the complex ion.

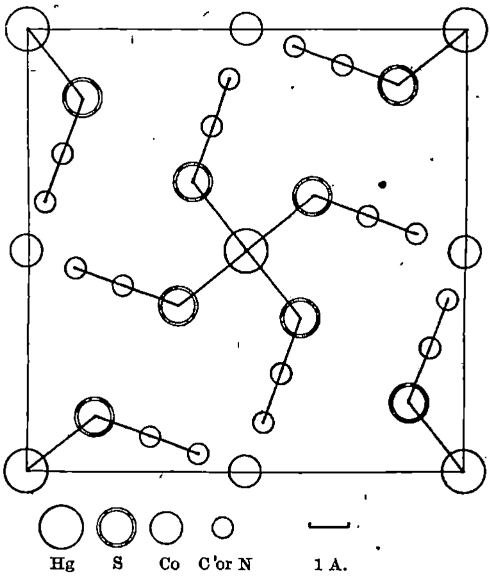
The compound crystallizes in deep purple, tetragonal, prismatic needles of crystal class $\bar{4}(S_4)$ and space group $I\bar{4}(S_4^2)$. $a = 11{\cdot}09$ A.; $c = 4{\cdot}37$ A. There are two molecules per unit cell.

From Patterson and Fourier syntheses of the $hk0$ and $h0l$ zones, the co-ordinates of Hg, Co and S are:

Hg: 0,0,0; Co: $\frac{1}{2},0,\frac{1}{4}$ *or* $\frac{1}{2},0,\frac{3}{4}$; S: 0·15, 0·13, 0·28.

This gives an Hg—S distance of 2·5 A. It appears reasonably certain that the S atom is attached to the Hg in tetrahedral co-ordination, with S—Hg—S angles of 120° and 104°.

The indications of the Fourier syntheses are that S—C≡N is straight, with N co-ordinated about Co (see diagram).



PROJECTION ON THE c-FACE

The investigation is being continued with the object of obtaining accurate co-ordinates for all the atoms.

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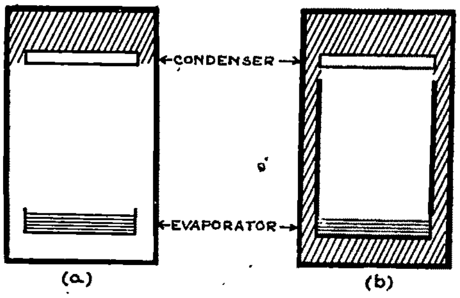
Effect of Shape of Operating Chamber in the Freeze-drying Process

A RECENT communication[1] discusses the freeze-drying process as conducted with the pressure of permanent gas, and the vapour pressure of the ice on the condenser, maintained at very low levels. Research on the application of the process to foodstuffs is being conducted at the Low Temperature Research Station, Cambridge. It seemed likely that the need to operate at extremely low pressures might be undesirable economically in such applications, and accordingly other factors which affect the efficiency of the process have been investigated, including air pressures up to 1 mm. mercury and condenser temperatures of $-20°$ C. and higher. The results show, as will be made clear below, that the design of the space in which freeze-drying is proceeding materially affects efficiency.

Using a frozen mixture of copper filings and boiled, distilled water as the evaporator in order to reduce temperature gradients, it is found that the vapour pressures in the immediate vicinity of the evaporating and condensing surfaces are sensibly equal to the saturation vapour pressures of ice at the temperatures of these surfaces. The air in the system distributes itself in such a way that the total pressure is everywhere the same, provided mechanical obstruction is negligible, so that more air collects near the condenser than near the evaporator. The variation of the partial pressure of air p from the evaporator to the condenser follows the law $p = A \exp. Bx$, where x is the distance from the evaporator, and the mean air pressure in the system can be calculated from the formula $\pi = \dfrac{p_c - p_l}{\log_e (p_c/p_l)}$, where p_c, p_l are the partial pressures of air near the condenser and evaporator respectively. It is presumed that this distribution of partial pressures results from a general movement of the mixture of air and vapour from the evaporator to the condenser, due to a difference in total pressure which is too small to be measured, together with movements of air and vapour by diffusion under their own gradients of partial pressure.

If a certain rate of heating be applied to the evaporator, its temperature takes up a value such that the resulting rate of drying removes an equal amount of latent heat. If the system is 'efficient' this will be achieved at a comparatively low temperature; an inefficient system will result in a high temperature. A convenient index of 'efficiency' in this sense is provided by the difference Δp between the vapour pressures at the evaporator and condenser which is set up when a standard rate of evaporation is maintained. It is found that Δp is directly proportional to the mean air pressure π over the range investigated (0·01–1·0 mm. mercury), so that from this point of view the amount of air in the system should be reduced to a minimum.

It has been mentioned that the partial pressure of air near the condenser is relatively high. Any space in the system which is 'screened' by the condenser also contains air at this pressure; and if this space is large, a substantial proportion of the air in the system will be driven into it when evaporation commences, so that the air pressure in the rest of the system will be considerably reduced. In this way a low value of Δp can be obtained even though the total amount of air in the system may be comparatively high. For example, a simple system such as that shown in (*a*) of the diagram gave $\Delta p = 1{\cdot}7$ mm. at a mean air pressure of 0·9 mm.; the addition of a tube as shown in (*b*) produced a considerable increase in the volume screened by the condenser, and a value of $\Delta p = 1{\cdot}1$ mm. was obtained.



CROSS-SECTIONS OF SIMPLE CYLINDRICAL DESICCATORS. THE AREAS SHADED ARE SCREENED BY THE CONDENSER

The appearance of the condensed ice varies with the air pressure and the temperature of the condenser. At low pressures and temperatures, the formation is similar to that described by Bradish *et al.*[1] with a slightly milky appearance. At temperatures of $-10°$ C. and thereabouts, with low air pressures, a glassy, transparent deposit of maximum density is obtained. At air pressures in the neighbourhood of 0·5 mm. mercury, the deposit is milky with a surface of flat, crystalline facets up to 3 mm. across; and pressures of 1 mm. mercury and above give a completely opaque, 'granular' deposit.

Further work in progress includes an investigation into the drying characteristics of various foodstuffs.

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Feb. 28.

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[1] Bradish, C. J., Brain, C. M., and McFarlane, A. S., *Nature*, **159**, 28 (1947).

Velocity of Electromagnetic Waves

THE determination of the velocity of light has attracted the attention of many scientific workers and, in spite of the experimental difficulties involved, its value is now known with a probable error of about 5 parts in 10^5. The velocity of electromagnetic waves, represented in Maxwell's theory by the quantity $1/\sqrt{\mu k}$, where μ is the permeability and k the permittivity of the medium, is generally assumed to have the same value as that of light; and although the electrical measurements made so far are less accurate than those of the velocity of light, they have served to establish the equality of the two constants within the limits of experimental error. Other electrical methods have become practicable as a result of the techniques employing centimetric waves developed during the last few years. The one dealt with in this note depends on the electrical resonance of a short length of a wave-guide closed at both ends. The frequency of resonance of a cylindrical guide of diameter D and length L is

$$f_n = v \sqrt{\left(\frac{r}{\pi D}\right)^2 + \left(\frac{n}{2L}\right)^2},$$

in which v represents $1/\sqrt{\mu k}$, r is a constant for a particular mode of resonance and n is the number of half wave-lengths in the guide.

This formula is based on the assumption that the walls of the guide are perfectly conducting. Their finite conductivity can be taken into account by introducing a small correction factor in terms of Q, the quality factor, of the resonator. The value of v then becomes

$$v = f_n \left(1 + \frac{1}{2Q}\right) \Big/ \sqrt{\left(\frac{r}{\pi D}\right)^2 + \left(\frac{n}{2L}\right)^2}.$$

The quantities f_n, D, L and $\left(1 + \dfrac{1}{2Q}\right)$ can all be measured with a precision of a few parts in 10^6, and the accuracy of a single measurement should therefore compare favourably with that of the velocity of light, which is based on a large number of observations.

Measurements of the velocity in a vacuum have been made, using the E_{010} and E_{011} modes in one particular resonator. The values of the velocity term obtained for the two modes differ by 2 parts in 10^5, the average value for the velocity of electric waves in a vacuum being

$$v_0 = 299,793 \text{ km./s.}$$

The maximum error, including residual effects due to the method of coupling the resonator to a source of oscillations, is estimated to be ± 3 parts in 10^5, which is approximately ± 9 km./s.

The value of velocity is 17 km./s. greater than that generally accepted for the velocity of light, although the values are not in disagreement when the combined limits of error are taken into account. In view of the possible discrepancy, however, it is proposed to make measurements of other modes in resonators of different shapes, in order to obtain further experimental evidence of the possible sources of error.

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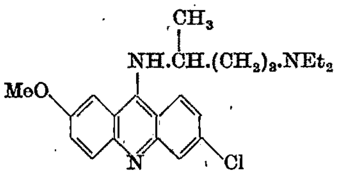
Resolution of Mepacrine

MEPACRINE (2-chloro-5-(δ-diethylamino-α-methylbutyl)amino-7-methoxyacridine) has been resolved by Tschelincev and Osetrova[1], by the use of what they describe as αα′-bromcamphorsulphonic acid.



Mepacrine

We have failed to effect resolution with any of the available bromcamphorsulphonic acids, though Dr. Trenner, of Merck and Co., U.S.A., has succeeded with *d*-α-bromcamphor-π-sulphonic acid[2]. We have, however, carried out a complete resolution by means of *d*-4 : 6 : 4′ : 6′-tetranitrodiphenic acid. Full details will be given in another place; in the meantime, we wish to record our values for the specific rotation of the hydrochlorides of the optical antimers in water. We find:

$[\alpha]_D^{14°} = -379 \pm 6°$ (m.p. 244–5°, decomp.; uncorr.).

$[\alpha]_D^{10°} = +388 \pm 7°$ (m.p. 244–5°, decomp.; uncorr.).

Tschelincev and Osetrova[1] give:

$[\alpha]_D = -357°$ (m.p. 243°, decomp.).

$[\alpha]_D = +358{\cdot}6°$ (m.p. 243°, decomp.).

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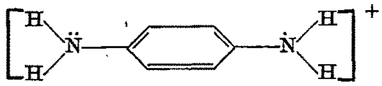
[1] Tschelincev and Osetrova, *J. Gen. Chem.* (*Russ.*), 10, 1978 (1940).

[2] Bachler, Buhs, Hetrick, Reiss and Trenner, *J. Amer. Chem. Soc.*, April 1947.

Polymerization of a Semiquinone Ion

THE most recent theory of the structure of Wurster type dyes (oxidation products of *p*-phenylenediamines) is that of Granick and Michaelis[1]. One of their main conclusions was that polymerization of a semiquinone ion of the type depicted below is impossible



when all the amino hydrogens are substituted. In support of this conclusion, they instanced the existence of a crystalline perchlorate of Wurster's Blue (the oxidation product or δ-salt of tetramethyl paraphenylenediamine)[2] the paramagnetism of which indicates the presence in the molecule of one unpaired electron.

By oxidizing tetramethylbenzidine with aqueous bromine in the presence of sodium perchlorate, we have prepared a deep-green crystalline perchlorate which catalytic micro-reduction shows to be on the oxidation level of a semiquinone. The striking thing about this green salt is that it is diamagnetic ($\psi_M = -166 \times 10^{-6}$ c.g.s. units). Thus polymerization of this semiquinone ion occurs in spite of the fact that all the amino hydrogens are substituted. It is clear that some modification of the existing theory of polymerization of semiquinone ions of the above type is required. Details of proposed modifications and work on related compounds will be published shortly.

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[1] Michaelis, L., and Granick, S., *J. Amer. Chem. Soc.*, 65, 1747 (1943).

[2] The paramagnetism of the perchlorate of Wurster's Blue was first studied by H. Katz, *Z. Phys.*, 87, 242 (1933).

Size Versus Colour in Air-Sea Rescue

I AM indebted to the Air Ministry and especially to the civilian staff of the Air-Sea Warfare Development Unit for a copy of the valuable report on "The Optimum Dinghy Colour for Air-Sea Rescue". Colours were tried from a yellow close to the Schott glass O.G.1, through orange and fire orange, near Schott O.G.2, onwards to traffic red and post-office red, like Schott R.G.1. The overall average visual range of the five coloured *M*-type dinghies for all-round weather conditions around the British Isles was approximately 1·7 nautical miles (3·15 km.). The waters were mostly greenish, but this is not always so on our coasts.

For the blue Mediterranean the visual ranges were, yellow dinghy 4 naut. miles (7·41 km.); orange and fire orange, 3 naut. miles (5·56 km.); reds, 2·5 naut. miles (4·63 km.). These are significantly different. But there was no such difference between the maximum visibility distance as a definitely coloured object on any sea colour. On green and blue seas, the observers favoured dinghies which appeared orange. This agrees with my own observations using the Schott glasses at sea, for the clearest view is obtainable with O.G.2.

After preliminary tests, the observations were made at 240 m. The diameter of the dinghy being 2·5 m. the angular size at the limiting ranges was, as the report points out, of the order of 0·05°. Actually the size is about one minute of arc for the greatest range (7·4 km.), nearly two minutes for the red range (4·6 km.) and nearly seven minutes for the British waters range (3·15 km.). Now Helmholtz has shown that the minimum perceptible brightness difference increases from about 2 per cent for an angular size 3° ; from his curve one finds (by extrapolation) that the minimum perceptible brightness difference has increased to about 40 per cent for the 7-km. range, about 35 per cent for the 5·5-km. range, and for the 3-km. range to about 27 per cent. As the effect of the atmosphere is to introduce a greyness into the colours, it is clear that the high values of the minimum perceptible brightness differences are the real limits to vision. Put simply, the objects become too small to see, quite irrespective of their colour.

It should be possible to increase the 'size' of the object by liberating oil. In the past, use has been made of fluorescein powder, which should the "multitudinous seas incarnadine", and this has been given off by airmen's suits (namely, packet on life-jacket). But the colour is obviously soon diluted, and in any event a volume effect is produced as against a surface effect for oil. The action of the latter is, according to N. K. Adam, "to damp out the small ripples which are constantly being formed by the action of wind". The water surface at a distance makes, therefore, a smaller average angle with the eye, and so its reflexion is greater. This reflexion amounts to 40 per cent for 5°, and is increasing rapidly as the angle between sea and line of sight diminishes. There is, in addition, the difference due to the refractive indices of oil and water; but a trial on calm water showed this to be negligible. I am indebted to Prof. Adam for the guess that a fuel oil will spread to a thickness of at most one micron on a clean sea ; at this one should have the higher orders of interference colours, which are surely observed. One kilogram of oil would, therefore, cover at least 1,000 sq. metres, giving a patch 30–40 m. in diameter. At the farthest range observed, namely, 7·4 km., such a patch would subtend an angle of about 15′, corresponding to a minimum perceptible brightness difference of about 17 per cent, as against 40 per cent for the dinghy; for British waters, 3·15 km., the angle would be 35′, corresponding to a 7 per cent minimum brightness discrimination. Thus increase in size should considerably extend the visual range, for dinghies plus oil, as against dinghies alone.

An obvious method of increasing the angular dimensions of an object is, of course, to use field-glasses; but it appears that the limitation of the field of view renders them valueless in ocean search —at least, no mention was made of them in the report.

The rate of spreading of oil on water may be about 12 m. a minute[1], so were a dinghy to liberate oil on sighting an aeroplane, a good-sized patch should rapidly be produced. So many factors are concerned in trials of this sort that direct observation seems the only way to reach a conclusion.

W. R. G. Atkins

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March 10.

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[1] Adam, N. K., "Physics and Chemistry of Surfaces", 213 (1941).

Chemical Effects of Moonlight

The article by Dr. C. F. C. Beeson in *Nature* of October 26, p. 572, is a welcome attempt to sort out the many conflicting references to a subject of much importance and of wide interest. Numerous factors go to the growth of a plant, and I felt many years ago that it was necessary first to find out the chemical and physical effects of moonlight under simple controlled conditions. The research was carried out chiefly under the bright moonlight of South Africa. Moonlight is partially polarized, the maximum effect being with the oblique reflexion of half-moon, or somewhat later for the waxing and earlier for the waning moon.

The experiments were as follows :

(*a*) Exposure of seeds to the night sky at periods of half-moon and of no moon. There was marked increase of germination in those seeds in which the testa was thin and transparent. These experiments were simply exploratory but led to the inquiry as to the effect of moonlight on reserve food material.

(*b*) Exposure of starch grains, washed and mounted on a microscope slide, *without* a cover glass. No diastase was added, but the water contained 0·05 per cent sodium chloride as co-enzyme. After about three hours the slide was covered and left to dry. Crystals were seen forming within the grains and exuding from them, also in the surrounding film of liquid.

(*c*) Exposure of a film of *boiled* starch. On drying, crystals were seen forming stars and rosettes, and on treating with Fehling solution the change to a sugar was indicated by countless specks of cuprous oxide.

(*d*) In the living plant (chiefly in South Africa). Young leaves of *Tropæolum* and of spinach were partially covered by tinfoil, leaving a small portion exposed to the moonlight. In the exposed region the starch disappeared, while the covered portion still gave the blue colour with iodine. This effect was also shown in a shaded vine-leaf[1]. A similar effect can be produced on films of boiled starch on filter paper. A penny placed on top of a sheet of *thin* glass, with a film of starch on the under side, after exposure to moonlight, gave a distinct image of the shadow on staining the film with iodine.

(*e*) At the request of a consulting timber engineer, determinations of the sap content at different phases of the moon were commenced. Equal weights of vine stems were boiled and the solutions were tested for sugar after (i) a period of half-moon, (ii) after an equal period of minimum light. The result showed nearly twice as much reduction in the first case as in the second: (i) required 16·5 c.c., (ii) required 29·9 c.c. of the solution to reduce equal quantities of Benedict solution.

From these experiments, the results of which are similar to those obtained with artificially polarized light[2], it appears that moonlight, being polarized, has a hydrolysing effect on reserve food, that is, it acts as a digestive tonic. Now to live on digestive tonics, especially without extra food, may be disastrous—hence the conflicting results which have been recorded.

Most of the experiments referred to above are quite simple, and can easily be reproduced. They should help to dispel the idea of 'superstition' and 'old wives' fables'.

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[1] *Nature*, **130**, 243 (1932).

[2] *Bot. Gaz.* (Dec. 1930). *Nature*, **144**, 379 (1939). Baly and Semmens, *Proc. Roy. Soc.*, B, **97** (1924).

RESEARCH IN BRITISH COLONIAL TERRITORIES

UNDER the title "Colonial Research, 1945–46" there have been issued (Colonial No. 208. H.M.S.O., London, 1947. 1*s*. net) the third annual reports of the Colonial Research Committee and the Colonial Products Research Council, the second annual report of the Colonial Social Science Research Council and the first annual reports of the Colonial Medical Research Committee and the Committee for Colonial, Agricultural, Animal Health and Forestry Research.

The year 1945–46 marked the completion of the main organisation and framework in London for the continuous survey of the needs of Colonial research, and the report of the Colonial Research Committee, after summarizing the arrangements made, appropriately takes stock of the results of some six years experience of the provision for research under the Colonial Development and Welfare Act, with which the Committee has been concerned since its creation in 1942. The cumulative total of research allocations under the Act now exceeds £1,000,000, and of 105 schemes made during the period since the Act came into force, 54 were made during the year 1945–46, when actual expenditure was £93,306 as against £58,345 in the previous year; the total expenditure to date is £202,565.

A main function of the Committee is to achieve the maximum degree of co-ordination of effort as between the various branches of science represented not merely by the bodies reporting in the present publication but also by the Economic Research Sub-Committee of the Colonial Economic Advisory Committee, the Colonial Fisheries Advisory Committee, the Tsetse Fly and Trypanosomiasis Committee, the Colonial Survey and Geophysical Committee and other specialist committees which are directly advisory to the Secretary of State for the Colonies. This task is being eased as there become available the long-term development plans of the various Colonies and regions with reference to the best use of the development funds available under the Colonial Development and Welfare Act. These plans indicate where the major efforts will be made and where in consequence a parallel research effort will be of the greatest value. Moreover, the Committee considers that studies of the bases of plans already formulated or being formulated are among the most fruitful objects to which a part of the research effort may be directed, and may constitute the essential foundation for fruitful research in many fields and for wise and efficient development planning.

While this report lists in an appendix the schemes recommended and finally approved during the period April 1, 1945–March 31, 1946, the Committee records progress only in those fields not covered by one or other of the specialist bodies. The report notes that it has now been decided to proceed with the scheme for establishing a central organisation for geodetic and topographical surveys, and Brigadier M. Hotine has been appointed director of Colonial (geodetic and topographical) surveys. The scheme, in which the Royal Air Force and the United States Army Air Force are participating, will allow the topographical mapping of large areas of the Colonies at a speed far in excess of anything achieved by ground methods before the War. It will also make available air photographs which can be of considerable value to forestry, agricultural and other officers in the Colonies in their ordinary work. Steps are also being taken to establish a Colonial geological survey on broadly similar lines, and work is expected to commence shortly on the preparation of plans for a freshwater fisheries research station on the shores of Lake Victoria at Jinja, Uganda, under a scheme to provide capital cost and running expenses for five years. Surveys of the Colonial fisheries in the Caribbean area have been completed, and plans are being drawn up for a fisheries research station for this area, which will probably be located in Trinidad. A further scheme provides a sum of £30,000 for the purchase and running costs for two years of a research vessel to investigate the fisheries of the Mauritius–Seychelles banks, which, it is hoped, will be in charge of Dr. J. E. Wheeler. Mr. J. S. Colman, lecturer in biology, University of Sheffield, completed a survey of the fisheries of St. Helena which suggested that policy should be directed towards improving the local supply of fish by means of better fishing methods and the improvement of distribution.

The Committee endorsed the recommendations of the report of the Colonial Housing Research Group for the establishment in Great Britain of a Colonial housing bureau for the collection and dissemination of information, to work in close association with the Building Research Station, and the establishment of housing research stations in the Colonies on a regional basis. It has also recommended the appointment in the Colonies of housing committees, representative of all the specialist interests concerned, and the appointment of an advisory committee in London; these proposals have been commended to Colonial Governments by the Secretary of State. As regards tsetse fly and trypanosomiasis, the main developments during the year were visits by Prof. P. A. Buxton, of the London School of Hygiene and Tropical Medicine, to East Africa, and by Prof. T. H. Davey, of the Liverpool School of Tropical Medicine, to West Africa, while the urgency of promoting experiments and research in the use of D.D.T. and other insecticides and repellents against tsetse led to a scheme for employing a Colonial Insecticide Research Unit in East Africa, for which a research grant of £41,500 over two years was made under the Colonial Development and Welfare Act. Arrangements were initiated for therapeutical field trials of phenanthridinium compounds. The Anti-Locust Research Centre has conducted extensive anti-locust campaigns with the usual methods of ground attack, but an Anti-Locust Flight of the R.A.F. has also been established with the object of exploring the possible use of aircraft; experimental operations in Saudi Arabia and in Kenya have justified further work.

In July 1945 a Land Tenure Advisory Panel was set up to advise on the general lines of research into native land questions and related matters; to review and co-ordinate the results of local investigations to provide information for the Colonial Governments on systems of land tenure; and to advise on research aspects of general questions of land policy.

The third annual report of the Colonial Products Research Council also reviews general progress Apart from research directly sponsored by the Council, notable progress has been made in encouraging and assisting workers already in the field, in effecting contacts and bringing new processes and discoveries to the notice of those who might be in a position to carry them further. A list of eight paten applications appended to the report illustrates th extent to which work has already reached a stage ripe for industrial exploitation. Importance continues to be attached to the personal contacts between workers in Great Britain and in the Colonies. Dr. H. H. Storey, director of the East African Industrial Research Board, visited Britain and discussed proposals with the Council for setting that organisation on a permanent footing.

Work under Prof. T. P. Hilditch has greatly improved and simplified methods for analysing vegetable oils and fats, and a number of oil-seeds are at present under investigation, including Ceylon and Nigerian rubber seed oils and citrus oil seeds. The investigation under Prof. A. R. Todd into the nature of the active principle in the flowers of *Hagenia abyssinica* (*Brayera anthelmintica*) has been actively pursued, and a list of indigenous plants of the Colonial Empire of possible medicinal or insecticidal value has now been completed and circulated. Work has also been carried out on the exact determination of the pain-deadening power of drugs; a method evolved which will detect the action of as little as 5 mgm./kgm. of pethidine hydrochloride is being used in the examination of the analgesic action of sugar derivatives prepared in Sir Norman Haworth's laboratory. The Council is also planning an investigation of really adequate means of studying the action of drugs on intestinal parasites of man and beast.

Substantial progress has been made with the work on sisal carried out for the East African sisal industry under Prof. J. B. Speakman, and has thrown much light on the fundamental nature and properties of sisal. Pyrethrum research at the Imperial College of Science and Technology under Prof. J. W. Munro has been hampered by inadequate facilities. The Council has also considered the technical equipment of the St. Vincent arrowroot industry, and it is hoped to devise in Great Britain much more efficient extraction methods. A wide programme of researches on starch at the University of Birmingham includes further fundamental studies on arrowroot as well as on potato starch and those from cassava, pea and rice. A detailed study is being made of the enzymes present in potato starch, and work on the utilization of sucrose has been concerned mainly with the dianhydrides of mannitol and sorbitol, lævulinic acid and methylolfurfuraldehyde. The examination of the ester fractions of naphthenic acids from Trinidad has commenced under Sir Robert Robinson, and plans for the design of a Colonial microbiological research institute in Trinidad have been approved. Pending the completion of the new laboratory, Messrs. Glaxo Laboratories, Ltd., have offered Dr. A. C. Thaysen accommodation at Greenford, Middlesex, where work on micromanipulation, the growth curve of *Torulopsis utilis*, the organism used in food yeast production, and on the antibiotic action of an actinomycete which yields a substance capable of inhibiting the growth of *Fusarium oxysporum cubense*, a fungus responsible for Panama disease of bananas, is being carried out. Contact has been maintained with the Tin Research Institute.

The second annual report of the Colonial Social Science Council again refers to the need for sound demographic data, and to the necessity of establishing local and regional social research institutes, which can survey the needs of the regions in which they are located and assume responsibility for the supervision and organisation of individual research projects. The Council has accordingly approved a grant to enable the Rhodes–Livingstone Institute to extend its programme of work in Central Africa, and is co-operating in the appointment of a director and staff for the Institute of Social Research attached to Makerere College in East Africa. The end of the War brought a slight mitigation in the shortage of personnel trained for social investigation, and in the meantime the Council has continued to favour team-research involving collaboration between workers in different disciplines, partly because of the direct advantages of such co-operation, and partly because not all the members of the team need have had previous field experience. Specific projects approved during the period include studies of the legal aspects of land tenure in the Gold Coast, the political organisation of typical communities in the Gambia, mental illness and juvenile delinquency in West Africa, grammatical structure of Kikuyu, social and economic conditions in the Aden Protectorate, and the occupational structure of representative communities in the Gold Coast as influenced by war-time Government expenditure. The latter survey and a computation of national income, production and expenditure in Northern Rhodesia and Nyasaland are under the supervision of the Economic Research Sub-Committee.

The first annual report of the Colonial Medical Research Committee refers to the appointment of Dr. A. F. Mahaffy as director of the new Colonial Medical Research Service, and joint secretary, with Dr. F. Hawking, of the Committee. The Committee has recommended that the Service should be staffed with men recruited for whole-time medical research and organised and controlled from Great Britain; although men might be seconded from it for research in the Colonial laboratories staffed by the local governments. It is planned to make the terms of service at least as attractive as those of the Colonial Medical Service, with liberal allowance for leave to continue or develop medical researches in Britain, and arrangements for pension or superannuation facilitating interchange of personnel between the Service and academic appointments in Great Britain. The Committee has agreed that special attention should be paid, as soon as possible, to problems of nutrition; the control of malaria and mosquitoes by new anti-malarial drugs and by the new insecticides; and to filariasis, schistosomiasis, and the physiology of hot climates; but the general policy has been to try to obtain men of initiative and originality and to encourage them to choose their own problems and methods of approach. To encourage training of young men for such research and specialist appointments, the grant of up to ten Colonial medical research studentships to graduates of British universities has been recommended. A Malaria Sub-Committee has been set up and has given its first attention to field trials and similar investigations on the new antimalarial, paludrine. The organisation of therapeutic trials in the Colonies of new remedies has been discussed generally, and it has been arranged that such requests should be made first to the Committee; and, where approved, the trials organised in accordance with the general policy of the Medical Research Council. The Committee has recommended to the Indian Medical Liaison Committee for sympathetic consideration a proposal to establish a small testing station in the tropics for examining chemotherapeutic substances acting on microfilariæ *in vitro*. Proposals for research on the physiology of hot climates have been discussed with Dr. S. S. Ladell; investigation of the epidemiology of an outbreak of poliomyelitis in

Mauritius in 1945 indicated that the disease was endemic, there being malnutrition, overcrowding and increased prevalence of intestinal disease throughout the island at the time. The Committee has also recommended that it should accept the responsibility for taking over and staffing in two years time the research laboratories which the Rockefeller Foundation has established at Entebbe, Uganda, and Lagos, Nigeria.

The first annual report of the Committee for Colonial Agricultural, Animal Health and Forestry Research, established in June 1945, gives the detailed terms of reference of the Committee, which are determined so as to delineate clearly the functions as between the Committee and the Colonial Advisory Council for Agriculture, Animal Health and Forestry. Full co-operation is secured by overlapping membership and close contact between the secretariats of the two bodies. The Committee met seven times during the period and has set up a sub-committee on policy to facilitate consideration of basic policy. The most important matters before the Committee were the re-organisation and expansion of regional agricultural research in East Africa, and the organisation of oil palm research in West Africa; both raised the question of the distribution of research effort between basic and general problems of given regions and problems of particular crops of actual or potential economic importance. Generally, the Committee inclines to the view that the basic and general approach is the one which will be most fruitful in the long run, and it has also reached the provisional conclusion that institutions are required which can devote themselves without interruption to the study of long-term problems. Questions of personnel and terms of service as well as of the control of scientific work have also engaged the attention of the Committee, which hopes to present in its next annual report a clear statement of the general lines of policy which it is intended to follow.

REPORTS OF THE ATOMIC ENERGY COMMISSION

THE first report of the Atomic Energy Commission to the Security Council of the United Nations, dated December 31, 1946, includes first reports also on scientific and technical aspects of the problem of control and on the safeguards required to ensure the use of atomic energy only for peaceful purposes*. The Commission records its approval of the former report from the Scientific and Technical Committee and incorporates in its findings the conclusions of that Committee. A summary is given of the second report, also approved by the Commission, which has reached the further general finding that scientifically, technologically and practically, it is feasible to extend among all nations the exchange of basic scientific information on atomic energy for peaceful ends, to control atomic energy to the extent necessary to ensure its use only for peaceful purposes, to eliminate atomic weapons from national armaments and to provide effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions. Effective control of atomic energy depends at present upon effective control of the production and use of uranium, thorium and their fissionable derivatives. The development and use of atomic energy are not regarded as essentially matters of domestic concern of the individual nations, but rather have predominantly international implications and repercussions. An effective system of control must be international and established by an enforceable multilateral treaty or convention administered and operated by an international organ or operation within the United Nations, possessing adequate powers, and properly organised, staffed and equipped for the purpose. International agreement to outlaw the national production, possession, and use of atomic energy is an essential part of any such international system of control and inspection, although standing alone such agreement would be ineffective.

In accordance with these findings, the Commission recommends the establishment of a strong and comprehensive international system of control and inspection, the scope and functions of which should be defined by a treaty or convention, and which should become operative only when those members of the United Nations necessary to assure its success have bound themselves to accept and support it by signing and ratifying the treaty or convention. It is recommended also that the treaty shall include a clause to the effect that the rule of unanimity of the permanent members of the Security Council shall not relate to the work of the control agency, and that no Government shall possess any right of veto over the fulfilment by the agency of any of its obligations under the treaty. In addition to promoting the exchange of basic scientific information on atomic energy for peaceful ends and its responsibility for preventing the use of atomic energy for destructive purposes, the agency should have responsibilities for research and development in order to remain in the forefront of atomic knowledge. The exclusive right to carry on atomic research for destructive purposes should be vested in the agency, which should also establish appropriate safeguards for research in nuclear physics having a direct bearing on the use of atomic energy. Such safeguards should not interfere with the prosecution of scientific research, or the publication of its results, provided no dangerous use or purpose is involved. The treaty or convention should embrace the entire programme for putting the international system of control and inspection into effect and should provide a schedule for the completion of the transitional process over a period of time, step by step, in an orderly and agreed sequence leading to the full and effective establishment of international control.

At its meeting on March 10, the Security Counci referred back to the Commission this first report with a request to prepare a draft treaty or convention incorporating its ultimate proposals, and to submit a second report before the next session of the Genera Assembly. Mr. A. A. Gromyko's statement of the U.S.S.R.'s position, on March 5, ignored the Commission's finding that prohibition of atomic weapons would be ineffective except as part of a system o international inspection. He rejected the whole idea of inspection and of infringements of nationa sovereignty, and distorted the conception of the international control agency developed in the report as well as the comments of the Council of the Atomic Scientists' Association on the American and Russia proposals before the Commission (see *Nature*, 159, 47; 1947) without advancing any constructive proposals to meet the difficulties he stressed. At the Security Council's meeting on March 10, Mr. W. R

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* See *Department of State Bulletin*, **16**, 105 (No. 394, Jan. 19, 1947).

Austin vigorously refuted the allegation that the United States sought either a monopoly or to impose its will on other countries in questions of atomic energy. Referring to the Declaration of November 15, 1945, by the President of the United States and the Prime Ministers of the United Kingdom and of Canada, Mr. Austin said that the United States Government had made it clear that it welcomed all constructive suggestions which might advance the solution of the common problem and fulfil the mandate of the General Assembly resolution. Strong support for the United States position was forthcoming from the French delegation, and those of China and Australia.

HORMONES AND FRUIT-FALL

THE year 1939 marked the publication by F. E. Gardner, P. C. Marth and L. P. Batjer of their important discovery that the spraying of synthetic growth-substances on young apples prevented the natural shedding of fruit, which often reduced the crop quite substantially. These findings have been confirmed and expanded by many workers, and Dr. M. C. Vyvyan, of East Malling, has summarized the large amount of research which has been done on the subject*.

Fruit-drop has several causes. It may arise from structural defects, from non-pollination, from various ypes of non-fertilization, and from the abortion of embryos; nutritional conditions also seem important. One section of the bulletin considers the proportion of blossom which will become mature fruit, and another part records some of the variations in fruit-fall according to variety. The mechanism of abscission may, or may not, involve cell division, and these differing types of fruit-fall may be related to variations in response to growth substances. Certain naphthalene derivatives, for example, exert a marked effect on pre-harvest drop of many apple varieties, but have little or no effect in preventing 'June drop'.

A careful and detailed tabulation of extensive results allows certain generalizations. For the control of fruit-drop with most varieties, "nothing better han naphthaleneacetic acid or the acetamide seems o be required". Evidence on the optimum concentration is rather conflicting, but in most cases it is probably best to use the 'standard' concentration of 10 p.p.m. Temperatures between spraying and picking seem to influence the duration rather than he intensity of spray effect. Rain may be harmful if it falls before the spray has had time to dry. Sprays vary in their duration of effect; they are not, however, in general, effective until five or six days after application, and remain active for two or three weeks. The timing of treatment is therefore most important. Pure naphthaleneacetic acid and acetamide are sparingly soluble in water; they are accordingly dissolved in a little alcohol before dilution. The synthetic growth-substances may also be applied as dusts, though further work is necessary before such convenient applications can be recommended for general commercial use. Results reviewed by Dr. Vyvyan do not suggest that fruit retained on the ree by hormone sprays has markedly different storage haracters from fruit ripened normally. Small variaions do, however, occur, and further work is desirable.

This bulletin is an admirable summary of work on the control of fruit-fall. It provides new horticultural equipment for the fruit grower and should give direction and stimulation to further research on the subject. Fruit-fall is not, however, always an unmitigated evil, and while pre-harvest drop provides the clearest need for control by hormone sprays, the ultimate practical control of previous 'drops' may lie in an adjustment, earlier in the season, of the amount of blossom to nutritional potentialities of particular trees. This gentle warning provides no disparagement of the volume under review, for Dr. Vyvyan's text does not introduce synthetic growth-substances as a panacea for all troubles. They rather provide a welcome remedy for a specific difficulty.

JOHN GRAINGER

BIOCHEMISTRY IN BELGIUM

THE relative scientific isolation of the enemy-occupied countries during the War has engendered a determined post-war effort on the part of research workers of such countries to use with the maximum efficiency opportunities to contact workers in other countries. The appearance of publications reviewing the work of the past seven years in as wide a manner as possible is one outcome of this determination.

A series of short monographs is now appearing under the general title "Actualités Biochimiques", published (Liège: Éditions Desoer; Paris: Masson et Cie.) under the editorship of Prof. Marcel Florkin, of the University of Liège. The first of these, written by Prof. Florkin himself in 1945, is entitled "Aperçus sur les Progrès de la Biochimie, dans les Pays Anglo-Saxons, Depuis 1940", and represents a bird's-eye view obtained from visits in June 1945, made possible by Le Fonds National de la Recherche Scientifique de Belgique. This volume surveys work carried out in the United States of America as well as that in Great Britain, and covers an extremely wide field effectively, but in a manner which is necessarily somewhat superficial. The subject of British anti-lewisite (*B.A.L.*) is treated in a later volume (No. 8, published in 1947, entitled "Travaux Récents sur les Toxiques de Guerre"), by Prof. Z. M. Bacq, in which the well-known fascinating story is told with all due credit to the genius of R. A. Peters.

It is unavoidable that the standard of the volumes of this series should vary, since the outlook of the authors is widely different. The second of the series, entitled "Données Récentes sur la Nature et le Métabolisme de L'Os", by Prof. Marcel J. Dallemagne (University of Liège), is an interesting exposition on bone metabolism in which the physical properties are discussed in relation to functional biochemical aspects, and which includes a useful section on hormones. No. 3, on "L'Évolution du Métabolisme des Substances Azotées chez les Animaux", by Prof. Florkin, is a very useful summary of work which is widely scattered and difficult to come by within the covers of one volume, and it is a tribute to biochemists in Belgium that such an insistent interest is shown in comparative aspects of the subject. No. 4 is the first of more than one volume dealing with new methods of clinical analyses, entitled "Méthodes Nouvelles D'Analyse Biochimique et Clinique", by Ghislaine Duchatéau (University of Liège), a subject on which it appears that more information will be given later. No. 5 (Pierre Fredericq) discusses "Données Récentes sur la Coagulation du Sang", while No. 6 deals with

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* Imp. Bur. Hort. and Plantation Crops, Tech. Comm. No. 18; obtainable from I.A.B. Sales Branch, Penglais, Aberystwyth (1946). s. 6d. net.

"Acquisitions Récentes dans le Domaine de L'Enzymologie" (Prof. L. Massart). No. 7, by Claude Liébecq (University of Liège), is a useful discussion under the heading "Conception actuelle du Catabolisme de L'Hémoglobine".

The volumes announced for future publication include: "Données Récentes sur les Phosphatases", by Jean Roche and Nguyen-Van Thoai; "L'Acide Ribonucléique", by Jean Brachet; and "Données Récentes sur les Antigènes Bactériens. Constitution chimique et Propriétés Biologiques", by A. Boivin.

This series will be of interest not only to Belgian biochemists but also to all who wish to see a review of recent work provided in a concise form, which although it is by no means exhaustive, provides a key to the most important literature of the last seven years.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, May 5

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London W.C.2), at 5 p.m.—Dr. D. A. Spencer: "Recent Developments in the Application of Photography" (Cantor Lectures) (further lectures on May 12 and May 19).

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting; Mr. E. Holmes: "Plant Hormones with special reference to Selective Weed Killers".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. Arthur Duxbury: "The Presentation of Technical Information".

CHEMICAL SOCIETY, BIRMINGHAM BRANCH (in the Chemical Lecture Theatre, The University, Birmingham).—Mr. M. C. Paine: "Careers in Chemistry".

Tuesday, May 6

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Dr. B. A. Southgate: "The Re-Use of Waste Waters from Industrial Processes".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. D. A. Oliver: "Heat-Resisting Steels".

Wednesday, May 7

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 11 a.m.—Discussion on "Naval Aircraft".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London W.C.2), at 5 p.m.—Mrs. G. E. Abbott: "Gas in the Home".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Major Kenneth Gordon: "The Development of Hydrogenation and Fischer-Tropsch Processes in Germany".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. R. A. Smith, Dr. E. Franklin and Mr. F. B. Whiting: "Accurate Measurement of the Group Velocity of Radio Waves in the Atmosphere, using Radar Technique".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. R. R. Goodall and Dr. A. A. Levi: "A Microchromatographic Method for the Detection and Approximate Determination of the Different Penicillins in a Mixture".

INSTITUTION OF CIVIL ENGINEERS, NORTH-WESTERN ASSOCIATION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Annual General Meeting, followed by a Discussion on "The Contract System in Civil Engineering".

BRITISH INSTITUTION OF RADIO ENGINEERS, NORTH-WESTERN SECTION (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Mr. E. C. Cherry: "Single Side-Band Communication Channels".

Thursday, May 8

PHYSICAL SOCIETY (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 4.30 p.m.—Annual General Meeting; at 5 p.m.—Prof. D. Brunt, F.R.S.: "Some Aspects of the Heat Balance of the Human Body" (Presidential Address).

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. G. Vines and Mr. M. F. R. Mulcahy: "The Initial Stages of Explosion in Nitroglycerine"; Mr. R. G. Vines and Mr. M. F. R. Mulcahy: "The Propagation of Detonation in Thin Layers of Nitroglycerine".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (at Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Prof. Chi-Yuen Wu: "The General Economic Conditions and Future Development of China" (further lecture to be given on May 22).*

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. F. Freeman and Mr. H. V. Mather: "Special Electrical Requirements of a Viscose Rayon Factory".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. E. S. Moult: "The Development of the Goblin Engine".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Miss W. Hackett: "Capacitors—their Manufacture and Testing".

Friday, May 9

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 3 p.m.—Sixth Annual General Meeting; at 3.15 p.m.—Mr. E. W. H. Selwyn: "Photographic Resolving Power of Lenses".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. M. G. J. Minnaert: "The Fraunhofer Lines of the Sun" (George Darwin Lecture).

CHEMICAL SOCIETY, NEWCASTLE AND DURHAM SECTION (at King's College, Newcastle-upon-Tyne), at 5 p.m.—Prof. E. L. Hirst, F.R.S.: Bedson Club Lecture.

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Mr. C. L. Hirshman: "Television Picture Quality".

UNIVERSITY OF GLASGOW (in the Chemistry Lecture Theatre), at 7.30 p.m.—Dr. Douglas Guthrie: "William Cullen and his Times" (other lectures in celebration of the Bicentenary of the Lectureship in Chemistry will be given on May 16, 23 and 30).*

Saturday, May 10

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DIVISION FOR SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE (at the University, Manchester).—Conference on "The Place of Universities in the Community".*

Tuesday, May 6—Saturday, May 24

TOWN AND COUNTRY PLANNING ASSOCIATION (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Exhibition: "Thirteen Nations Plan for Better Living" (to be opened at 3 p.m. by Mr. Lewis Silkin).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on o before the dates mentioned:

SENIOR ASSISTANT FOR ELECTRICAL ENGINEERING—The Principa Municipal Technical College, Hopwood Lane, Halifax (May 10).

SENIOR POST IN THE ACOUSTICS SECTION of Research Departmen based in London—The Engineering Establishment Officer, Britis Broadcasting Corporation, Broadcasting House, London, W.1 (May 10)

EDITORIAL OFFICER—The Honorary Secretary, Society of Dyer and Colourists, 32–34 Piccadilly, Bradford, endorsed 'Editorial Officer (May 10).

LECTURER IN SURVEYING in the Mining Department—The Registra The University, Leeds 2 (May 15).

CHAIR OF BOTANY in the University of Tasmania—The Agent General for Tasmania, Golden Cross House, Charing Cross, Londo W.C.2 (May 15).

HEAD OF THE SCIENCE AND TECHNICAL DEPARTMENT of the Norwoo Technical Institute, Knights Hill, West Norwood, London, S.E.27—The Education Officer (T.1), County Hall, London, S.E.1 (May 17).

LECTURER (Grade II), an ASSISTANT LECTURER (Grade III), and a ASSISTANT LECTURER (temporary), in the DEPARTMENT OF PUR MATHEMATICS—The Registrar, The University, Liverpool (May 22

LECTURER and an ASSISTANT LECTURER IN PHYSICS, a LECTURE and an ASSISTANT LECTURER IN CHEMISTRY, an ASSISTANT LECTURE IN ZOOLOGY, and an ASSISTANT LECTURER IN BOTANY AND ZOOLOG (with special reference to Cytogenetics)—The Registrar, The University, Sheffield (May 24).

LECTURER IN BACTERIOLOGY, a SENIOR LECTURER IN PHYSICA CHEMISTRY, and a LECTURER IN FUEL TECHNOLOGY—The Registra The University, Sheffield (May 24).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF GEOLOG —The Registrar, The University, Liverpool (May 27).

PROFESSOR OF GEOLOGY—The Registrar, University College Wales, Aberystwyth (May 30).

PAINT ADVISER by the Government of Nigeria—The Director Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

LABORATORY ASSISTANT IN THE DEPARTMENT OF PHYSICS, and LABORATORY ASSISTANT IN THE DEPARTMENT OF CHEMISTRY—Th Registrar, University College, Singleton Park, Swansea.

ENGINEER with practical knowledge of drawing, design and develo ment, a CHEMIST for physico-chemical research, and DEVELOPMEN OFFICERS (chemists or chemical engineers, preferably with some work experience)—The Director, British Launderers' Research Associatio Laboratories, Hill View Gardens, Hendon, London, N.W.4.

SENIOR LECTURER IN PHYSICAL CHEMISTRY—The Clerk to th Governors, Northern Polytechnic, Holloway, London, N.7.

PHYSICIST for research work in high-vacuum technique—Th Director and Secretary, British Scientific Instrument Researc Association, 26 Russell Square, London, W.C.1.

TEMPORARY POST in London with the Directorate of Ordnan Factories, Ministry of Supply—The Ministry of Labour and Nation Service, Technical and Scientific Register, Room 171, York Hous Kingsway, London, W.C.2, quoting F56/47A.

LECTURER IN PHYSIOLOGY AND ZOOLOGY—The Registrar, Technic College, Sunderland.

Office of Science & Culture CALCUTTA

NATURE

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INCENTIVES IN MANAGEMENT AND PRODUCTION

ALTHOUGH in his speech at the outset of the debate in March in the House of Commons on the economic situation in Great Britain, Sir Stafford Cripps emphasized the importance of the necessity for some incentive element, throughout the wages structure, which would be an inducement to a higher rate of productivity, and elaborated further the policy foreshadowed in the White Paper in that respect, the Budget proposals showed little evidence of the Government's intention to implement that policy. The debate on the economic situation tended to concentrate attention on this question of incentives, and on that of securing the most effective distribution of man-power. Mr. Lyttleton brought strong support to Sir Stafford Cripps' observations on the importance of incentives, and Wing-Commander Millington's example of the increase in output of bricklayers from 80 bricks to 462 bricks per man per day as a result of incentive schemes shows what can be done by the introduction of incentive schemes into wage systems.

The vital bearing of both these factors on the industrial and commercial efficiency, on which, as Sir Andrew Duncan rightly said, rising standards of living, increased leisure and social security all depend, was fully displayed in the debate, although the significance of the Prime Minister's remarks about mixed incentives was passed over. Doctrinaires on either side will do real harm by attempting to exclude either the public or private interest motives. Few men and women are not influenced both by the idea of public service and by private profit, and which incentive is the more effective will depend on circumstances, and on the type of person. What needs to be remembered is that the question of incentives is not restricted to one particular class: it is as important among the professional and managerial class of workers as among the manual workers. While, however, the importance of efficient management is now widely recognized, the question of management incentives has received nothing like its proper attention. It is fully as important as that of the wisest distribution of our resources in administrative ability, over which such concern was expressed in the House of Commons debate on man-power on March 19.

Taking the brain-power of Great Britain as a whole, we have to do two things. On one hand, we have to see that it is deployed to the best advantage—that neither the Armed Services nor the Civil Service are allowed to draw excessively on the limited resources of trained man-power, scientific or otherwise, leaving the universities each year, and that within the Services as in industry those resources are fruitfully and fully employed. On the other hand, we have to see that the conditions of service are such as to stimulate those men and women to exert to the utmost the abilities which they possess.

It is realized that the allocation of technical knowledge between the competing demands of defence, industry, medical research, etc., is no simple task. Even a system of priorities demands constant scrutiny and revision, and only incessant vigilance can eliminate waste even if man-power has been allocated in accordance with the most rigorous and satisfactory scheme of priorities. Moreover, the debate on defence on March 20 gave rise to some uneasiness that in certain fields the distribution of trained man-power is out of balance.

In a speech in the defence debate on March 19, Mr. A. V. Alexander announced that during the coming year some £60 millions would be spent by the Admiralty and the Ministry of Supply in scientific research and development. He had already, in the debate on the economic situation in Britain, indicated that, of the man-power in the Armed Forces, some 46,000–47,000 were engaged in such work. The estimated expenditure of £3,118,000 of the Department of Scientific and Industrial Research includes some for military purposes, and the grants to universities and agricultural colleges and institutes include large sums for maintenance and teaching costs and the usual apparatus of student life; hence *The Economist* is probably not far wrong in its estimate that out of an anticipated expenditure of slightly less than £19 millions for research during 1947–48, including that on the Agricultural and Medical Research Councils, Colonial research, the universities, and research financed directly by the Department of Agriculture and Fisheries, only some £10 millions is used for research proper.

The contrast between this £10 millions and Mr. Alexander's £60 millions is striking, even when we bear in mind that the figures do not include the unknown but considerable expenditure of private industry on research. But whether the comparison is by expenditure or by man-power, the picture seems out of balance, and however readily it may be possible to justify the expenditure on military research—and the stress laid in the defence debates on the importance of scientific development and research is a welcome and reassuring feature—it at least appears probable that the economic position of Britain makes further assistance necessary from the Exchequer for research in fields bearing on industrial development. Mr. Alexander stated that the Defence Research Policy Committee and the Advisory Council on Scientific Policy would be in general control of policy and priorities, and would concentrate their energy on stimulating research in fundamentally new fields which scientific discoveries have opened up. On the picture thus presented, they will need to grapple more seriously with the distribution of the country's scientific man-power and material resources than the Government has yet attempted to do. It is at least a sound reason for Sir Henry Tizard's tenure of the chairmanship of both bodies.

The distribution or redistribution of man-power in any field is admittedly a difficult problem; but despite the attention focused upon it in recent debates, few constructive proposals have been forthcoming either from the Government or the Opposition. Reliance appears to be placed in the main upon incentives, and although the operation of a system of incentives either as a factor in attracting man-power or brain-power where the interests of the nation most require them, or in increasing output, is handicapped by shortages of raw materials, equipment and labour, the importance of incentives is not easily over-stressed. For all that, Mr. R. A. Butler appears to have been alone in the recent debate on the economic situation in stressing the importance of incentives for the management and others in industry as well as for the manual workers.

The point has not entirely escaped Political and Economical Planning, which in a recent broadsheet "Men, Management and Machines", pointed out that first-class management will not be obtained while every manager is liable to indiscriminate politica denigration. The psychological factors are in fact even more important than the financial incentives for the manager, and also for the research worker and an interesting little note "The Requirements for Fruitful Research" printed in a recent issue of the *Journal of Chemical Education* (24, 165; 1947) is rather marred by its failure to recognize this. In this article a distinction is drawn between the worker in pure science and the worker in applied science and the investigator in applied science is designated interpreter.

The distinction between pure and applied research is much less clear-cut than is suggested in this note though it is rightly urged that the function of the applied research worker is "to deliver the goods", and that industry will judge his success by the measure in which his work leads to practical results. Few research managements, however, would to-day agree that adequate material rewards alone would suffice to attract the best men in adequate numbers Individual rather than mass psychology is also important, and for fruitful industrial research th atmosphere and conditions of work are little less important than in fundamental research in the university. The atmosphere of freedom matters, too even if there must in the nature of things be restraint that do not, and should not, apply in the university where fundamental research finds its natural home

What is overlooked in this little note is the interaction between the university and industry. If it important that a university should rigidly guard its freedom and abstain from entering the field of applied research, it is equally important that condition within the university and within industry should b such as to foster the free and full exchange both staff and of knowledge. Neither will benefit from disparities in conditions of service, financial or otherwise, which denude one or the other of a prope proportion of the highest type of ability it need One of the greatest problems facing Great Britain in fact to provide in industry and in the publ service conditions which stimulate to the highe degree the creative thought, the enterprise an adventurousness which mark the ideal investigat at the university seeking to extend the bounds human knowledge.

That indeed is the position taken up by Mr. W. Wiegand, director of research of the Columbia Carbon Co., in a paper, "Motivation in Research" in *Chemical and Engineering News* of October 25, 1946. Mr. Wiegand emphasizes the complex character of motives or incentives in research, and observes that it is a mark of true insight to foster and encourage the adventurous phase of research. The competitive spirit, he holds, cannot be ignored, and need not be discouraged. Mr. Wiegand recognizes the value of a generous publication policy and of taking care to ensure that individual recognition is forthcoming for good work; but however careful we may be to establish the right conditions of service, the spark of leadership will always be indispensable for the most fruitful results. Motives and emotion are indivisible; and a friendly, loyal and appreciative management is as vital a factor in research as it is in the handling of men in production or distribution, and one which no elaborate equipment or careful organisation can displace. Indeed, the very fact that industrial research depends so much upon teamwork enhances the importance of leadership in this sense as contrasted with the direction of research.

The point was well brought out by Mr. L. C. Gabriel in his chairman's address to the Road and Building Materials Group of the Society of Chemical Industry last year. Industrial research must obviously conform to a long-term predetermined plan, and the leader of any research team must exercise mental discipline to ensure a proper relation between achievement and the agreed plan. Much latitude in detail must be allowed to all responsible staff, and the control from above must seek essentially to promote a voluntary discipline to prevent helpless drift and to turn individual enthusiasm into profitable channels.

Such psychological factors are more important than the physical conditions of work. This is not to deny that a research team works most fruitfully in a modern well-equipped laboratory, with pleasant surroundings, facilities for reading and writing and for formal and informal discussion, nor to suggest that there are not many industrial and indeed academic laboratories which fall far short of any reasonable standard in this respect. But it is well to remember that, in research as much as in industry at large, there is a factor of management or leadership which is indispensable to enable our objectives in research or in production to be attained; no organisation, on the national scale or in the laboratory itself, which disregards this factor can hope to succeed or to secure that higher standard of productivity and greater output upon which national recovery depends.

From this point of view the problem is similar whether we approach it from the aspect of labour or from that of research. The manager or administrator has to take account increasingly of the human factor and to devise the conditions of work and the incentives which will induce men and women willingly to give of their best. In so far as nationalization of an industry promotes such an atmosphere of co-operation—as is probably true in the coal industry—it is *a priori* to be welcomed, provided there are not other factors in nationalization which militate against efficiency. It must be borne in mind that so far there has been little evidence that the public corporation provides the conditions of service or the incentives which stimulate enterprise, initiative and first-class efficiency in the administrator in quite the same way as the best concerns in private industry.

It has already been suggested that this may well be our biggest problem. It is admittedly difficult and complex, but there are new opportunities opening up before us, and new instruments being created which may be used to find the way to a solution. It is one to which the National Coal Board may rightly be expected to give some consideration, and it is pre-eminently one for consideration and study by the new British Institute of Management and the Administrative Staff College. Other bodies too, such as the Institute of Industrial Administration and the National Institute of Industrial Psychology, have contributions to make, and the trade unions themselves could help if they were minded to take a more positive and constructive view of their functions. Bonus schemes and other financial incentives for the research worker and manager might well be re-examined objectively by such bodies; but much more is required. The creation of the right atmosphere and conditions of co-operation, and the discovery of the organisation and intelligence system which industry and society need to meet the increasingly complex demands of to-day, require co-operation from many quarters, and above all in the same spirit of impartial patient searching for truth which animates the research worker in his own laboratory investigations. Moreover, the growing importance, if not necessity, of a scientific approach to labour problems, as urged by Mr. W. C. Puckey in a stimulating paper before the Royal Society of Arts on January 29, with all that such an approach connotes, in training for management and in a scientific outlook on the part of the manager, emphasizes once more the necessity of a considered attempt to ensure that the administrator, no less than the research worker, is both adequately trained for his job and also given the essential conditions for doing it.

INDIA AS A SOCIAL KALEIDOSCOPE

Caste in India

Its Nature, Function and Origins. By Dr. J. H. Hutton. Pp. viii+279. (Cambridge: At the University Press, 1946.) 18*s*. net.

THIS 'brief conspectus' is for students, and assumes in its readers some knowledge of India and anthropology. Dr. Hutton claims no novelty, and draws freely on the accounts of Blunt and O'Malley (1931–32) and on his own Census Report of 1931, two important extracts from which, on 'untouchables' and on primitive religion, are reproduced *in extenso* as appendixes.

The ground is covered in three sections, each of four chapters. Part 1, "The Background", after a rapid glance at the races and languages of India, gives a short account, province by province, of such castes and tribes as illustrate the "almost incredible diversity" of Indian society. Part 2, "Caste", is concerned with (1) "Structure", the interaction of marriage restraints and social status, and safeguards against *mésalliance*; (2) "Strictures" on food and drink, on custom and occupation; (3) "Sanctions", caste councils and other controls, the offences they try, their procedure, oaths, ordeals and penalties; (4) "Functions", the effect of caste for good or ill on the individual, the community, the State and society generally. Part 3, "Origins", discusses (1) institutions analogous to caste in other civilizations; (2) the traditional origins of caste in India (mostly from Chapters 6 and 12 of Dr. Hutton's Census Report of 1931); (3) theories of modern writers, and (4) conclusions drawn from the evidence.

All this is familiar; but the picture differs sharply from that drawn by nineteenth-century scholars, who, on the evidence of Sanskrit scriptures, traced caste (and civilization generally) to 'Aryan' invaders. But 'Aryan' culture as depicted in the Rigveda has little in common with Hinduism. Later research has revealed abundant evidence of elements typical of Hinduism in the pre-Vedic civilization of the Indus Valley cities and in the beliefs and practices of non-Aryan castes and tribes. The sources of Indian society and religion lie deeper and wider than the Sanskritists supposed. Presumably Rigvedic culture was absorbed into a strongly established indigenous culture of far older date.

The elaborate restrictions on marriage in India, the most prominent feature of the caste system, Dr. Hutton suggests may partly be due to "the impact of patrilineal invaders on an indigenous matrilineal population", and infers from good evidence that matrilineal descent, which still flourishes on the west coast, was at one time widely distributed throughout India. On these lines he would explain the prevalence of hypergamy, cross-cousin marriage, pre-puberty marriage, purdah and temple prostitutes.

Restraints on 'interdining', on the giving or taking of food and water, as well as pollution by touch, he ascribes to ideas of magic, mana, 'soul-stuff', life matter, etc., conveniently grouped as 'power' (p. 202), a sort of dangerous energy inherent in certain persons and things, the operation of which Sir James Frazer has aptly compared with that of electricity, which not so long ago was called a 'fluid'. Such taboos are common to all humanity, civilized as well as primitive; they have a practical value in a country where the population of a village may be decimated in a night by cholera, and vermin-borne disease may devastate the homes of 'untouchables', leaving their cleanlier high-caste neighbours unharmed.

Another big factor in shaping caste is the caste council. Each caste claims to discipline its own members. Brahman influence is indirect; Brahmans set standards of 'correct' behaviour and purity, and can withdraw their services in the ceremonies associated with birth, marriage and death in other communities, but they have no decisive authority in matters of caste. In early India such authority was vested in the king, and it still survives in many Indian principalities; but State jurisdiction is mainly appellate and adjusts disputes between caste and caste. The initiative in framing caste law and rules of conduct (*dharma*), the right to expel or re-admit, lie within the caste. The constitution and working of caste councils present every conceivable variety, and it is significant that the lower the caste in the social scale the stronger the organisation for regulating its own affairs, and it is strongest in tribes outside the pale of Hinduism. Obviously caste autonomy was neither invented by Brahmans nor imposed by State decree.

In assessing the merits of caste, Dr. Hutton stresses its value as a bond of union in a 'plural society', by which a multitude of disparate communities are welded into a social whole, yet retain each its own character and way of life; and he contrasts the 'stability' of caste from time immemorial with the warring nationalities of Europe and the colour problems of Africa and America.

Caste, in short, is an 'organic' growth, the product of many factors interacting within India over a long period of time, factors well known outside India; but, as Dr. Hutton observes in reviewing "analogous institutions", nowhere but in India do they produce a caste system. Moreover, like living organisms, the system is in perpetual flux, and has been so from time immemorial, constantly adjusting itself to changes in environment, ethical, economic, religious and so forth, new castes splitting off from old castes, and old castes rising or falling in the social scale; so mutable is it that no account of it can remain accurate for long. Criticizing not ungenerously the views of previous writers, Dr. Hutton deprecates approach from "a single view point", and makes no attempt to define the indefinable. Instead, he concludes with a list of the more obvious factors which have made caste what it is.

This compact essay should serve its purpose well. References are given in footnotes wherever needed; bibliography, glossary and index are excellent, and the student can thread his way easily through the haze of fact and fiction that surrounds caste.

F. J. RICHARDS

PRACTICAL FRUIT-GROWING

Fruit Growing Outdoors

By Raymond Bush. Pp. 518+105 plates. (London: Faber and Faber, Ltd., 1946.) 18*s*. net.

THE ready sale of Raymond Bush's Penguin Series of booklets on fruit-growing demonstrates the keen demand that exists to-day for sound advice on gardening topics, especially when presented in the easily assimilated form that characterizes the writings of Mr. Bush. The fact that here and there the expert can detect partial truths or inaccuracies detracts little from the general usefulness of the advice to the practical man, and provides the more knowledgeable man with opportunities for delighting himself in finding Mr. Bush at fault. No claim is made that the books are based on research findings, and it is obvious that they are not; but where it has suited the author he has made use of proved facts, and where it has not suited him, or where such facts are lacking, he has inserted his fancies with equal weight. Actually, his advice is very sound on the whole, as he is speaking about things with which he is thoroughly familiar after a lifetime of fruit-growing, for some years commercially and more recently as an amateur.

While the Penguin booklets are admirable for reading on a journey or carrying in the pocket, they lack the permanent binding and presentation that is needed for a book that will be used for constant reference. There can be no doubt, therefore, that the publication of these fruit-growing booklets in a single volume will meet with general approval. Messrs. Faber and Faber have made the thorough job that one expects of them—clear, readable type nicely arranged on good paper, the whole being tastefully bound in a handy-sized volume, though more care in proof reading might have avoided the many small errors that occur in both text and index.

Reprinting of this nature, however, raises problems, some of which have not been very happily solved in this case. Two courses of action seem legitimate: either the separate parts reprinted in one volume should preserve the original matter intact, or if revision is permitted it should be thorough. While the first course is the simplest, the latter course has obvious advantages for the reader, and the scale of the present reprinting would have made such revision an easy matter. Mr. Bush has, however, adopted an intermediate course, making enough changes to lull the reader into a false feeling of up-to-dateness while leaving unaltered many other equally simple alterations. Thus, while "Lebensraum" becomes in a de-Nazified world "Elbowroom" (p. 337), and "Sir William Beveridge's" plans become "Socialist" ones (p. 222) with the change of Government, no reference is made of the valuable supplement to T. Wallace's "Diagnosis of Mineral Deficiencies" in the footnote on p. 94, where the original publication is mentioned. Reference is still made to a grafting booklet (p. 42), by R. J. Garner, that has been out of print for eighteen months or more, and the price is some three years out of date. The spraying chart remains untouched by recent knowledge, and stirrup pumps would seem to be still occasionally used for incendiary bombs (p. 183). The opening paragraph of Chapter 3 refers to the small space at the disposal of Mr. Bush in contrast to that in Mr. Bagenal's "Fruit-growing"; while this was true of one volume of the Penguin series, Mr. Bush's omnibus volume contains 496 pages in contrast to Mr. Bagenal's 416 pages!

The original illustrations have all been carefully re-drawn for this edition. The artist has made good use of the better facilities for reproduction afforded by this book, and the general effect is cleaner and neater. The result might have been better still if the artist had drawn direct from Nature instead of faithfully copying Mr. Bush, as he was not always quite correct in the original. For example, in Fig. 4 the bud looks quite unlike an apple bud, and the slit to accommodate it is inconveniently short. More care is needed in checking with the text those figures that have been altered; typical discrepancies occur with Figs. 64 and 65 and p. 362, where the footnote is no longer needed, Fig. 37 and description on p. 207, and p. 472 where the figure referred to does not appear.

The chief addition to the original volumes is the fine collection of plates. Few books of this nature are so well illustrated. Other valuable additions are line drawings of the chief insect pests, a section on renovating old trees, another on growing bush peaches and brief references to D.D.T. and the artificial setting of tomatoes. It is difficult to see why Section 3 was honoured by a re-written introduction when the fact that the original introduction was no longer suitable might have been seized on to omit it altogether, thus assisting the unification of the parts. It is surprising that it was considered necessary to number the chapters in parts since the pages are consecutively numbered right through, and the present arrangement leads to awkward cross-references in the text.

Considered as a handbook on fruit-growing, the arrangement could be much improved. It is disconcerting, for example, to find the subject of planning a fruit garden dealt with piecemeal in each of the three parts, with certain overlapping. The same is true of spraying. The chapter on books would be more appropriate at the end, and the important subject of spring frosts might have appeared nearer the beginning. The presence of chapters on nuts, mushrooms and tomatoes in the Soft Fruit Section seems scarcely justified. Naturally, one must accept this arrangement in an omnibus volume, but it is a pity Mr. Bush did not spare time to rearrange or rewrite the original Penguin booklets into a carefully planned manual covering the whole field of fruit-growing.

There is little doubt, however, that "Fruit Growing Outdoors" will find an honourable place on the bookshelves of keen amateurs, professional fruit-growers and even hardened research workers.

H. B. S. Montgomery

BREEDING OF FARM ANIMALS

The Breeding of Farm Animals

By Chapman Pincher. (Penguin Handbooks, PH.10.) Pp. 150+7 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1946.) 1*s.* net.

ATTEMPTS at popular exposition of the scientific principles of farm livestock breeding have usually been made by those who have worked in one or other of the many fields of study which make up this 'practical' subject. No doubt, it is because of the intricacy of the considerations involved that the authors usually refrain from too sweeping or dogmatic statements, although they must recognize that their efforts to meet popular approval and appreciation are thereby weakened. Here, a fresh attempt to get some of the newer knowledge across to the practical man is made by an author whose name is hitherto unfamiliar in this particular connexion. Mr. Pincher brings his journalistic experience into action, and traverses reproduction, genetics, breeding policies, beliefs, and practical problems in pursuit of his objective.

He apologizes to professional biologists for certain conscious sacrifices to clarity in his treatment of the reproductive processes. But it must be confessed that this apology in itself raises doubts as to the origin of his lack of clarity and precision in other aspects of the general topic. His compilation of facts and his interpretations are open to criticism from men of science and practical men alike. As examples, from the many: few geneticists would agree that "The only test for the purity of a dominant character in a beast is to cross it with another animal known to be impure for that character", or that the F_2 ratio for a single pair of genes, with dominance, is 1 : 3 : 1; both groups of people would doubt the implication that true hermaphrodites are common in poultry flocks; and most sheep-breeders would object to the Black Welsh being included if the main breeds of mountain sheep were to be restricted to six.

The author has made a courageous attempt to expound principles usually considered applicable; but commendation is withheld for two main reasons. First, the numerous blemishes could easily have been removed without much effect on the content or the style of the book. Secondly, as at best such a text could only serve as an introduction to the subject, and not be entirely authoritative in itself, a general bibliography or selected references should have been given.

J. E. Nichols

SPONTANEOUS COMBUSTION OF HAY

By Dr. J. B. FIRTH and Dr. R. E. STUCKEY
Home Office Laboratory, Preston

THE self-heating of hay has long been a subject on which many conflicting theories have been put forward. Our recent work[1,2] has provided data which may perhaps help to give a clearer understanding of the processes preceding spontaneous combustion.

Early Theories

A number of the theories put forward were undoubtedly influenced by the prevailing chemical concept of the day. There were, for example, theories put forward dependent on the pyrophoric properties of certain elements, notably carbon, iron and manganese, when in a finely divided condition. Thus, Buckner[3] in 1872 introduced a theory centring about the idea of pyrophoric carbon and its absorptive power for atmospheric oxygen. Ranke[4] in 1873 made a detailed examination of a heated stack and was probably the first to describe hay which, when forked out, sparked and burst into flames. This phenomenon was held to support the pyrophoric carbon theory, and the attainment of the high temperature necessary for pyrophoric carbon formation was attributed to the insulating properties of the hay.

The stumbling block in these theories was the question of how the hay could arrive at such a high temperature, and to overcome this difficulty Miehe[5] (1907) put forward his low-temperature carbonization theory. In this it was assumed that the temperature was taken to 70° C. by thermophilic micro-organisms and never rose above 70°–80° C., a slow carbonization taking place. The interaction of the fine carbon produced and atmospheric oxygen caused the final ignition. This theory, however, has since been proved to be untenable, as James and Price[6] have reported fires due to spontaneous combustion which occurred in less than five days from the wetting (due to floods) of hay.

Boekhout and de Vries[7] considered that ionized iron in the cell sap had a catalytic action, while Laupper[8] held pyrophoric iron and not pyrophoric carbon to be responsible. The latter investigator worked out an extensive scheme showing products at various stages in a stack, introducing at the final stage pyrophoric manganese. There can be little doubt that in the later stages of the heating, pyrophoric carbon will be produced; but this is probably true of the prolonged heating at high temperatures, in the absence of air, of any similar organic material. The point is that the pyrophoric substances are only secondary in action and have no bearing on the main cause of the heating.

Another phase of theories was originated by Tschirch[9], who strongly criticized Miehe's low-temperature carbonization theory, advancing the view that not bacteria but oxidase enzymes were responsible, through production of oxygen which was 'pent up' and caused rapid oxidation and heat. Burri[10], modifying this, postulated heat-resisting enzymes, though later Hildebrandt[11] concluded from experiments that enzymes could not be responsible, and criticized the theory of Tschirch. Hildebrandt reverted to the assumption of the activity of micro-organisms as an explanation.

These theories are open to criticism mainly on the grounds that although certain experiments were carried out in their support, conclusions were drawn on evidence which was not related to the intermediate and end-products of self-heating actually present in a stack. This drawback probably originates in the difficulty of observing stacks which have undergone spontaneous combustion. Investigation of numerous stack fires during the war years (more than a hundred and fifty fires have been examined, including fifty samples of self-heated hay at all stages of development and heating) has given us opportunities of examining and trying to explain the processes occurring.

Certain fundamental facts are available on which any explanation can rely. Cohn[12] (1890) showed that approximately 40° C. was the highest temperature reached by means of ordinary plant respiration, but there was a further rise to 70° C., possibly due to thermophilic micro-organisms. Miehe (*loc. cit.*) isolated numerous organisms and named *B. calfactor* as being responsible. The work of Haldane and Makgill[13] also supplied evidence in support of this.

Browne's Theory

Browne[14] (1929), in an excellent review of the subject, made the first real attempt to put forward a logical explanation of the self-heating in the decomposition of substances by micro-organisms, followed by a chemical effect producing the breakdown of sugars in the presence of ammonia—a number of reports having mentioned the odour of ammonia around a stack.

According to this view, there was no difference in the mechanism of the heat production between 50° and 70° and above 70°, the heat being due in both cases purely to chemical causes. Browne states: "In other words the micro-organisms simply produce the highly unstable compounds whose subsequent oxidation . . . generates the increasing quantities of heat that lead first to the destruction of the organisms themselves and then eventually to the ignition of the hay". This theory was held to be supported by experiments showing the production of unstable unsaturated compounds from sugar by the action of lime.

Browne adds: ". . . the foregoing explanation of the spontaneous combustion of hay may be criticized on the grounds that there is no evidence for the existence of such highly unstable intermediary compounds as this hypothesis requires".

A New Approach

In our opinion the theory of Browne is essentially true. We have, however, never found a stack, heated or not, which was alkaline in reaction. All were slightly acid, and the spontaneously heated stacks very strongly so. Ammonia is probably present at some stages from protein breakdown; but we have not actually encountered it, and it is certainly not present to such an extent as to cause carbohydrate breakdown in alkaline medium.

Our preliminary work[1] showed certain features of a self-heated stack, chiefly (in a chemical sense) the gradual development of an acidity which was at a maximum in dark brown hay before such hay had reached the actual temperature of carbonization and destruction of products. Stacks showed in general two effects of spontaneous combustion; in one of these there was a large, central, heated portion with general conflagration and no visible 'flues'; in another, the heated portions were more distinct and a number of 'flues' were shown which smoked and smouldered although the stack might not actually be burning.

Further work[2] on the chemical constitution of the acidity showed that the non-volatile fraction consisted of lactic, malic and succinic acids, while the volatile acids acetic and formic were also present. Lactic and acetic acids predominated. The total acidity was up to 8–9 per cent calculated as lactic acid on the dry matter, and a number of samples analysed later contained as much as 12 per cent. Since acetic acid, the main volatile acid, is present, it is very probable that the real acidity was much higher than actually found, volatile acid being lost in the heating process.

Considerable loss of volatile acidity is in fact unavoidable, and it is noteworthy that in cases where the stack was specially cut for us, and samples were taken from inside and immediately transferred to air-tight containers, the acidity was of a higher order and the volatile acidity proportionately greater.

It is obvious that the production of acidity is a big factor, and almost certainly the main factor, in self-heating, and that any satisfactory theory must take this into account. It is also clear the acidity is derived from carbohydrate breakdown.

The examination of the type of acidity gave, in our opinion, a very definite lead to the processes taking place. Typical results were as follows:

	1	2	3	4
Volatile acidity calculated as acetic acid percentage on dry hay	1·51	1·20	1·17	0·36
Residual acidity calculated as lactic acid percentage on dry hay	5·33	4·32	4·81	2·37

This shows good agreement with the acidity present in silage of higher acid values. Watson[15] quotes the following analysis of ordinary silage of varying *p*H values:

	1	2	3
Volatile acids calculated as acetic acid percentage on dry hay	3·21	2·91	4·01
Residual acidity calculated as lactic acid percentage on dry hay	8·44	4·33	2·60

Figures are rather variable, and obviously in such a complex and cumulative action as carbohydrate breakdown even a slight variation in conditions may lead to big variation in the resulting products.

The composition of the acidity of silage determined earlier by Annett and Russell[16] was remarkably similar to that found for self-heated hay. Thus, Annett and Russell found that the fixed acidity contained lactic, malic and succinic acids; the volatile acidity contained acetic and formic acids. The striking similarity between the composition of silage and self-heated hay indicated that a study of the processes occurring in silage would most probably provide the answer to the problem of the haystack.

In silage the crop is alive in the silo and for the first stage is actively respiring, aerobic changes taking place while the air in the herbage is used up. When this occurs, the second stage starts and intracellular respiration or fermentation takes place. The cells die, and micro-organisms begin to multiply, using as a medium the contents of the dead cells. The chief changes in the silo consist of the breakdown of the carbohydrates with the production of carbon dioxide, alcohol, and organic acids including acetic and lactic acids. Proteins are also broken down, though this may, perhaps, be an action secondary in importance so far as spontaneous heating is concerned. The exclusion of air, either partial or total, is necessary for the proper production and preservation of silage. The temperature of the mass usually rises, varying with the efficiency of exclusion of air.

In the silo, conditions are such that there is a plentiful supply of moisture but a limited and finally negligible amount of air. If air were admitted freely during the operation, a high temperature would result, and presumably spontaneous combustion would finally take place just as in the case of moist hay. In stack silage where exclusion of air is difficult, temperatures are high.

Suggested Actions Occurring in a Stack

In an ordinary well-made, well-dried haystack, there is a supply of air in the centre—not abundant, but sufficient. Some respiration occurs, the amount depending on the extent to which the drying process has killed the cells, and this is followed by the second stage, namely, microbiological action with the production of some breakdown products and acidity. This action is very slight in the ordinary, normal stack, but occurs further in the production of 'brown hay', popular on the Continent, with temperature rising often to 90° C., together with some caramelization of sugars. Fairly early, however, in a normal stack, a stage is reached when the amount of water is insufficient to allow further growth of micro-organisms, activity slows down and the stack cools off. Here *water* is the limiting factor preventing the continued growth of the micro-organisms.

In the case of hay which is undergoing spontaneous combustion, there is sufficient moisture present to allow further changes in the silage cycle, and the temperature rises rapidly if air is present to any extent (note that after flooding in Vermont, U.S.A., stacks 'fired' in four days). Carbohydrates are decomposed by micro-organisms to produce, for example, lactic and acetic acids from unstable intermediate oxidation and breakdown products. The porous structure of the hay helps in the process, and oxygen is absorbed from the air, oxidation occurring at points of molecular unsaturation with the production of heat. It is commonly known (cf., for example, J. Thompson[14]) and has been confirmed by us in the investigation of linseed oil-waste fires that the products of oxidation strongly catalyse the oxidation itself; that is, the process is autocatalytic. In addition, it is found that 40° C. is a critical point in the self-heating of waste contaminated with unsaturated oils. Above this temperature, spontaneous heating is much accelerated, and by raising the temperature to 40° C. combustion can be started in many materials which would otherwise not ignite.

Above 40° C., therefore, heat is being developed in the hay at an increasing rate. Towards 100° C., water is driven off to outer layers and we get a change, in that the reaction is taking place for the first time in comparatively dry medium. Earlier in the cycle, water was a limiting factor, curtailing the growth of micro-organisms; lack of oxygen now becomes the limiting factor until the decomposition, often following the path of hot gases produced, reaches the outside of the stack. There the excess of oxygen produces enough heat to cause fire.

The processes occurring in wet hay, ordinary normal hay and silage are summarized below.

Self-heated Hay.

(1) Respiration takes place causing the initial rise in temperature. The amount of respiration depends on the extent to which the plant cells have been killed in the drying process.

(2) Micro-organisms develop rapidly in the presence of moisture and with the rise in temperature, attacking the cell sap constituents and initiating decomposition.

(3) Rise in temperature up to *c.* 40° C. kills plant cells and respiration ceases. Some thermophilic micro-organisms may continue to be active above 40° C. Sufficient water and air are present to allow growth to continue. Breakdown of carbohydrates produces unsaturated compounds which are oxidized and partly hydrolysed with the production of heat.

(4) At temperatures above 40° C. the micro-organisms are gradually killed off by the temperature. *The decomposition products are then sufficient in amount to catalyse further decomposition of carbohydrates.* The increased temperature gives a greatly increased rate of oxidation of unsaturated compounds, as shown experimentally for unsaturated fatty oils.

(5) At 100° water is driven off from the heating centre, and oxidation and hydrolysis are replaced by oxidation with production of more heat. The limiting factor now is the amount of air present.

(6) The rate of chemical reaction increases sharply until the surrounding hay is charred and access to air is gained. Here, the plentiful supply of oxygen gives heat which cannot be conducted away, and ignition occurs.

Ordinary Hay.

(1) Some respiration takes place causing rise in temperature, the extent depending, as with self-heated hay, on the extent to which the plant cells have been killed in the drying process.

(2) Micro-organisms develop with rise in temperature, attacking cell constituents. Decomposition is slight, *the growth of the organisms being limited by the lack of water.*

(3) Decomposition is insufficient to set up the autocatalytic reactions, and the stack cools off.

Silage.

(1) Respiration takes place until all oxygen is used up or replaced by carbon dioxide.

(2) Micro-organisms develop and operate in the absence of air. The limiting factor here is the lack of air, and the interior of the silo cools off. Breakdown products of carbohydrates are produced; but there is insufficient air for any extensive oxidation to take place, and the heat developed is small in comparison with wet hay.

[1] Firth, J. B., and Stuckey, R. E., *J. Soc. Chem. Ind.*, **64**, 13 (1945).

[2] Firth, J. B., and Stuckey, R. E., *J. Soc. Chem. Ind.*, **65**, 275 (1946).

[3] See Ranke, H., *Ann.*, **167**, 361 (1873).

[4] See ref. 3.

[5] Miehe, H., "Die Selbsterhitzung des Heues. Eine Biologische Studie" (Jena, 1907).

[6] James, L. H.. and Price, D. J., *Science*, **67**, 322 (1928).

[7] Boekhout, F. W. J., and de Vries, J. J. O., *Centr. Bakt.*, **44**, 290 (1915).

[8] Laupper, G., *Landw. Jahrb. Schweiz.*, **34**, 1 (1924).

[9] Tschirch, A., Mitt. Naturf. Gesell. Bern, 133 (1917).

[10] Burri, R., *Landw. Jahrb. Schweiz.*, **33**, 23 (1919).

[11] Hildebrandt, F., *Centrbl. Bakt.*, ii, **71**, 440 (1927).

[12] Cohn, F., *Jahresber. Schles. Ges.* (Breslau), **68**, 23 (1890).

[13] Haldane, J. S., and Makgill, R. H , *Fuel*, **11**, 380 (1923).

[14] Browne, C. A., "The Spontaneous Combustion of Hay", 38 (U.S. Dept. Agric., 1929).

[15] Watson, S. J., "The Science and Practice of Conservation; Grass and Forage Crops", **1**, 279 (1939).

[16] Annett, H. C., and Russell, E. J., *J. Agric. Sci.*, **2**, 382 (1908).

THE CULTIVATION OF A THERMODYNAMIC OUTLOOK

THE place of thermodynamics in education was recently discussed by the Low-Temperature Group of the Physical Society. In outlining the purpose of the discussion, the chairman, Sir Alfred Egerton, explained that a feeling exists among members of the Group that the thermodynamics teaching given to students in Great Britain is often inadequate; and it was in the hope of formulating constructive proposals for its improvement that this meeting was called. He added that it was not his intention to confine discussion only to low-temperature aspects of thermodynamics, but to encourage discussion over the whole thermodynamic field.

Opening the discussion, Sir Charles Darwin pointed out the difference between the teaching of mechanics and of thermodynamics in Britain. On one hand, in the teaching of mechanics, the student is drilled to solve numerous examples until all the implications of Newton's Laws have been driven home. On the other hand, thermodynamics is often introduced in abstract terms and clothed in a maze of algebraic symbols, thereby leaving the student confused in his conception of the subject and ill-equipped to apply such thermodynamic knowledge as he has gained to new problems. Sir Charles thinks thermodynamics is a harder subject than mechanics, but not much harder.

Elementary teaching of thermodynamics in the past has been confined almost entirely to gases and liquids, and this has tended to obscure the generality of the subject. Also in setting examination questions too much demand has been made for the mathematical manipulations involved in getting, for example, from C_p to C_v. Now that the new fields of magnetism and the elasticity of rubber have been opened, other examples are available, and the teaching of thermodynamics can be widened in its outlook. Exercises in spotting the fallacies in perpetual motion machines also provide a useful field of instruction. The use of numerical examples should be extended, for only so can experience be gained of the relative importance of the various factors in a process.

In conclusion, Sir Charles Darwin posed three questions, to which he supplied his own tentative answers:

(1) Should thermodynamics play a greater part in education ?

(2) At what stage, school or university, should it begin ?

(3) Should statistical theory come in ?

To the first question he gave an affirmative answer. In answer to the second question he considers that a start should be made at school about two years after mechanics, but to be suitable for schools the text-books will need to be re-shaped. Regarding the third question, he favours withholding statistical theory, except for a few descriptive examples which call for no mathematics.

The next speaker, Prof. E. A. Guggenheim, stated his convictions that the number of people in the world who thoroughly understand thermodynamics in all its aspects is well under a hundred, and the number in Great Britain is certainly in single figures. He said, however, that he is less disturbed by these small numbers than by the degree of ignorance of thermodynamics by the remainder of physicists, chemists and engineers. Unfortunately, this includes people whose task it is to teach thermodynamics and to abstract papers on this subject. A symptom and, at the same time, a cause of this state of affairs is the failure to afford to thermodynamics its true significance and status by confusing it with the experimental techniques of thermometry and calorimetry, and the largely empirical laws of heat transfer, under the general title of 'Heat'.

Thermodynamics, he said, has a bearing on almost every branch of physics and particularly on mechanics, hydrodynamics, electrostatics, capillarity and chemistry. In these subjects many of the laws and formulæ taught are defined only under the condition of constant temperature—for example, Hooke's Law, Ohm's Law and Boyle's Law. As soon as one inquires into the effects of varying the temperature, one enters the domain of thermodynamics. This has led to much confusion in the use of the word 'energy' in such expressions as the 'energy of a coiled spring', or the 'energy of a charged condenser'. Here the quantity cited is usually the free energy, and the total energy is a more complicated quantity, since it is to be noticed that the performance of work at constant temperature is, in general, accompanied by a simultaneous absorption or emission of heat.

Prof. Guggenheim recommended that students, immediately after learning mechanics, should be made familiar with :

(1) the existence of temperature ;
(2) the conservation of energy ;
(3) the correct definition of heat ; and
(4) the distinction between actual and reversible processes.

The quantitative relationships between work and heat can best be introduced in particular examples, such as coiled springs, compressed fluids and charged condensers, as these subjects in turn come up. Only at a later stage is it necessary to stress that all such relations are particular examples of the general laws of thermodynamics.

Prof. D. M. Newitt, speaking of the bearing of thermodynamics on chemical engineering, stated that the aim of chemical engineering is to co-ordinate a series of elementary physical operations and chemical processes in such a way as to bring about economically some desired change of state or composition in a given system. It therefore requires equally a knowledge of thermodynamics and molecular physics. He considers it desirable that the teaching of statistical mechanics and the kinetic theory should run parallel with and not follow a course in thermodynamics since, in general, chemical engineering problems are concerned not only with the driving force necessary to bring about a specified change, but also with the rate at which that change can be made to take place.

Attention was directed by Prof. Newitt to the present unfortunate divergence, both of approach and of emphasis, in the teaching of thermodynamics to physical chemists on one hand, and engineers on the other. Thus the chemical engineer, who receives tuition in both schools, is liable to unnecessary confusion. The wide variation of notation between different text-books of both subjects has also added to the confusion. Prof. Newitt voiced the plea that uniformity of notation should be adopted in the teaching of thermodynamics. In conclusion, he suggested that more use might be made of graphical and geometrical representation in the teaching of thermodynamics. Exercises in the construction of such diagrams and models might well make up for the paucity of laboratory experiments for illustrating thermodynamic principles.

Mr. A. M. Clark said that, although a complete knowledge of thermodynamics may be restricted to a few, an understanding of the principles involved is important for all scientific workers, irrespective of the particular branch of the subject chosen for specialization. He considers that the first and second laws of thermodynamics are even more fundamental and more rigid than the basic laws of chemistry and mechanics, such as the laws of conservation of mass and Newton's Laws of Motion. The student should be introduced to them at the earliest possible stage, that is to say, at the same time as he learns to appreciate the other fundamental laws. For this purpose the early teaching of thermodynamics should be divested of advanced mathematics and complex nomenclature. Illustrations of the principles of irreversibility can be found in many simple processes. Yet fallacies are often encountered in scientific papers published in reputable journals, showing that these principles are imperfectly understood, even by some who aim at instructing others.

The next speaker, Prof. F. E. Simon, advocated that the first introduction to thermodynamics should be at school ; only so would the second law be quickly mastered. Moreover, this should be done even if it necessitates sacrificing some of the more tedious parts of physics. He lamented the present inadequacy of elementary thermodynamic text-books, and while commending Ewing's book, he considers the engineer's approach far too restricted. In teaching thermodynamics he considers the use of complicated systems and involved mathematical derivations inadvisable. The main difficulty experienced by students is in grasping the fundamental ideas implied by the thermodynamic laws, and the best way of elucidating them is by the use of numerous examples. In this connexion he considers the heat pump as one of the best illustrations for bringing home to students the significance of the second law.

Speaking as a physical chemist, Mr. C. R. Bury claimed that the modern precise thermodynamics is of little use in meeting practical problems. The work of Van t' Hoff gave us a method that is easy to apply, but the answer is unreliable. The modern thermodynamics is only useful with very simple systems, and as soon as a problem occurs requiring high pressures, mixtures, or solutions, the information is so scanty that the methods are useless.

Dr. K. Mendelssohn emphasized that in teaching thermodynamics the primary need is to explain what the subject is about and not to plunge into a mass of symbols. A study of the phenomena occurring at the transition from the superconductive to the non-superconductive state affords useful instruction.

Dr. M. Ruhemann disagreed with Sir Charles Darwin that Newton's laws are more readily understood than the laws of thermodynamics. He personally has found Newton's second law more difficult to understand than the second law of thermodynamics. He agreed with other speakers that thermodynamics should be introduced at school, and he considers that by embodying it in examples such as internal combustion engines and fuels it could be made interesting to these ages. He commended warmly the text-book by Boznjaković and expressed regret that it is not available in English.

Dr. N. Kurti directed attention to the fact that in many universities there are several parallel and simultaneous courses in thermodynamics for chemists, physicists and engineers. If, instead, a combined course of lectures was given with emphasis on the nature and scope of the subject, considerable benefit would result. Mr. J. H. Awbery added to Dr. Ruhemann's contention, that the laws of thermodynamics are no more difficult than those of Newton, the point that students at school are drilled in mechanics at an age before they can ask questions, and it is solely this discipline which makes mechanics seem far easier. If thermodynamics was hammered home at an early age with plenty of illustrations, the concept of free energy would be as easy to understand as volume or temperature. Dr. L. R. G. Treloar also agreed with this point, stating that thermodynamics should be taught as dogma. Only so will familiarity and confidence be attained.

Summarizing the discussion, Sir Alfred Egerton indicated several points on which agreement had been reached. First, elementary instruction in thermodynamics should be given at school, and for this a very carefully prepared syllabus would be required. Secondly, in teaching thermodynamics more use should be made of diagrams and solid models; and thirdly, a unified system of notation is desirable. In conclusion, he pointed out that in 1850 Clausius and Kelvin had simultaneously, though independently, formulated the Second Law of Thermodynamics, and he expressed the hope that in 1950 the centenary would be suitably celebrated.

G. G. Haselden

NATURAL SCIENCE AND THE FINE ARTS*

By F. IAN G. RAWLINS

Scientific Adviser, National Gallery

I PROPOSE to consider here the relations which we may expect to find existing between these two great examples of human endeavour. In so doing it will be seen that the man of science, using that term in the broad sense, has been instrumental both in the fashioning of objects of art and in caring for them afterwards. It appears likely that many of the great masters of classical art were somewhat casual in their concern, as judged by our standards, for the beautiful things which they made; nowadays conservation has become an art in itself, and the philosophers are not slow in pointing out that our preoccupation with the treasures of the past may be bound up with a certain lack of confidence in ourselves to generate loveliness in our own time. However that may be, there is much to be said for a close study of the techniques of the great masters, and such a discipline does, in fact, help us to devise ways and means of looking after our heritage more adequately.

Thus, the man of science needs to be something of a *Kunstforscher* as well as competent to apply any method or methods which will help forward objective investigations of structure and condition. Clearly, one should know a good deal about materials and their limitations, above all to be imbued through and through with a sense of 'safety first', if museums and galleries are to reap positive advantages from the possession of a laboratory and its equipment. The war years, too, have provided problems on a scale commonly associated with those in engineering.

The greater part of this discourse will be devoted to the physics of classical paintings, chiefly because I find myself rather less incompetent perhaps with them than with other material; and secondly on the score of their combined weight and fragility, which makes them probably the most intractable of all. From the technical point of view they fascinate, not merely artistically, but because they are frequently so 'awkward'. At the National Gallery, for example, we have pictures weighing anything from a few ounces to nearly three quarters of a ton. To design plant both convenient and safe for such a range is not too easy. In surface area as well there is wide variation, from about 20 square inches to 16,000 square inches. The apparatus in question consists essentially of X-ray, ultra-violet and infra-red sources of radiation, with appropriate recording gear, both photographic and visual. In addition, there is considerable scope for colorimetry and for microscopy in polarized light. Further, the orthodox methods of photography have been extended to include macrographs, the use of special filtration processes, and the employment of raking light. In all this, one is not looking for the production of something that looks like the picture; we are seeking information which, in general, can only be obtained in bits and pieces, here a little and there a little, by deliberate exaggeration or suppression as the case may be. It is only when a purposeful effort at integration is made that the significance of these separate approaches becomes apparent. No method is known which by itself will tell us all that we wish to know, and unfortunately there are many examples in which failure occurs in spite of everything.

Here perhaps is the place to emphasize that scientific practice and methodology will never be substitutes for stylistic knowledge and insight. A certain amount of harm has occasionally been done to the cause of laboratory co-operation by expecting it to achieve results of which it is *a priori* incapable. Nevertheless, its help in confirmation, and briefly, in lifting conclusions out of the region of subjective judgment, has been demonstrated time and again. This only amounts to asserting the obvious truth that the nature of evidence needs extremely careful thought when using such evidence under conditions wherein the original assumptions cannot well possess full formal validity. Maybe this is why, in matters of this kind, there has been much reasoning by analogy, that is, from particular to particular. Scientific method will strive to raise this one degree in the hierarchy by attempting to apply the process of induction (that is, reasoning from the particular to the general); so far as one can see, it seems most unlikely that the final, or deductive, system will ever be reached in scholarship of the type we are contemplating now, since argument from the general to the particular is almost a denial of the individualism of art. It is a fact, however, that a remarkable degree of agreement is often registered among people thoroughly conversant with questions of style, iconography and provenance, but this is not to say that objective testing has no place in these deliberations. Its verdict *may* be crucial.

My purpose thus far in sketching, necessarily briefly, the theoretical background of the scientific-artistic complex has been to try to elucidate certain basic suppositions which experience shows to be liable to misapprehension or even to neglect. It is easy to claim too much; equally faint-hearted is it not to realize the force of analytic and synthetic means as signposts on the journey. With these dispositions in mind, we can tackle the experimental problems which await us with greater confidence. To some extent, our advances must be by comparative methods, that is by the use of models, since obviously no risks can be run with irreplaceable originals.

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* Substance of a Friday evening discourse delivered at the Royal Institution on February 14.

We now discuss in some detail the physical structure of a typical painting in oil or in tempera. Its most marked characteristic is its stratified nature; that is, it is built up of a number of layers. These are, starting from the back: (1) the support; (2) the ground; (3) the paint film; (4) the surface film. The physical boundary lies between (1) and {(2), (3), (4)}, since the support is essentially—for our present purpose—composed of a biological fibre (wood or canvas, or both), whereas the three superincumbent members are film-substances, differing mainly in the amount of pigment and medium which they contain. They are traditionally enumerated separately more on account of their method of application and purpose than for their differing chemical natures.

At the moment, however, I propose to consider particularly (3), for the paint film *is* the picture as commonly conceived. It is the design itself, and upon it, essentially, the æsthetic value of the whole depends. In many cases the paint film is itself complex, consisting of a number of components. These often show a lack of continuity in one plane, a rough parallel with the 'faults' of the geologist. Again, imbrication is not uncommon, which adds many a trap for him who has forgotten to walk like Agag. In general, interpretation of structure is difficult, by whatever means it is attempted.

Within the paint film itself (that is, restricting ourselves to one plane), we are confronted with a sequence or gradation of properties depending in the main upon the relative properties of pigment and medium. Paint structures rich in pigment are called *granular* (examples are to be found in most fresco and wall paintings); those of medium concentration are known as *vehicular* (a large class containing most normal easel paintings); and finally, phases very rich in medium are termed *pellicular*. In this latter group are found the glazes and, in the limit, pure oil films. The important point to notice about this scheme, which is due largely to G. L. Stout of Harvard University, is that whereas chemically all these entities are simply so much paint, the ordinary appearance depends mostly upon the state of aggregation, while the physical properties such as transmission, reflectivity, permeability and so on show correspondingly transitional characters.

From the point of view of the impact of electromagnetic radiations, however, we are concerned more particularly with the chemical nature of the pigment particles themselves. Thus, as is well known, lead in any of its numerous compounds is very opaque to X-rays, and so, of course, are the other heavy elements. It is for this reason that our X-radiographs of a picture represent a kind of scaffolding of the 'edifice', delineated into areas of high lead content. Ultra-violet tests, on the other hand, function because of the capacity of certain pigments to excite fluorescence, an effect which is not independent of the medium, whereas discoloured varnish is often reasonably transparent to the near infra-red. Naturally, a complete examination will include all these methods, and, as indicated earlier, no one of them alone is likely to tell the whole story. In general, each has its particular part to play.

At the risk of falling into the sin of over-simplification, I should mention that there are two ways in which an artist may build up his structure. One is to allow the ground, that is, No. 2 of the strata already mentioned, to provide the body of the lighter parts of the composition, adding white lead, perhaps very thin, for the high lights. Franciabigio's Portrait is an example. Alternatively, the whole of the lighter areas, including the high lights, can be painted in lead, beginning, of course, with a dark, or darkish, background. A head by van Dyck shows this technique well. Actually it is unlikely that a specimen can be produced to give a complete case of either practice; most instances are mixtures of both, inclining perhaps more one way than the other. But the conception is a useful one for technical purposes, and X-rays are capable, in general, of exhibiting these distinctions satisfactorily. All the layers, unfortunately, except those which are exceedingly thin, are registered together, which makes interpretation all the more difficult and at times uncertain. By reducing the penetrating power of the rays, gradation is much improved. We use 14 kV. or 21 kV., with a current of 15 ma. at the National Gallery, and are planning to go to still lower potentials. Exposure times are from two to three minutes, depending, of course, upon the thickness and nature of the support, as well as upon the type of ground and paint film. Good results may be expected if the ground is of *Gesso* (plaster of Paris), but not if a lead priming is present, or if a lead-bearing adhesive has been used in the course of relining. Radiography is defeated in these cases.

The ultra-violet is occasionally a very powerful weapon in a museum laboratory. So far as paintings are concerned, it is possible to reveal retouchings and to observe to what extent the surface film is intact. A characteristic fluorescence is excited. It follows that if it is desired to study the paint film in this way, it is essential to remove the varnish, the fluorescence from which is usually intense enough to obliterate everything else. In general, the ultra-violet is a means of dealing with surface phenomena, the penetration being nearly zero. At the other end of the wave-length scale we have infra-red radiation. Certain practical difficulties are commonly encountered, but the method has great possibilities, greater perhaps than those of X-rays. The reason for this is that, with orthodox X-ray equipment, as already mentioned, superposition effects cannot be avoided, whereas, naturally, they do not occur with a reflexion phenomenon such as infra-red photography. Thus varnish, even when highly discoloured, is usually penetrable; and if this is the case, a much improved image of the paint film is obtained compared with an ordinary photograph. At their best, infra-red records can be very significant, particularly for such masters as Tura, Crivelli, and Cossa, where exceptional under-modelling is brought out, and their anatomical build-up displayed. From ordinary vision, most of this is hidden.

It has probably become clear that much of what I have been saying so far is applicable *mutatis mutandis* to a variety of museum material other than paintings. Instrumentation will be a little different, and probably there will be greater scope for chemical investigations. The ultra-violet has not infrequently proved effective in the detailed study of pottery, and, as is well known, for the elucidation of manuscripts and drawings. An ingenious application of electro-endosmose has been for the cleaning of pottery, of which the surface has become encrusted with salt crystals in which some pigment is entangled. The homely method of a good scrub with water would quickly end in disaster, since the precious coloured particles would be scattered far and wide by such treatment. But by immersing the vase in water, and inserting a cathode wire into it as one electrode, and using another wire dipping into the water as the anode, the salt crystals conveniently move off in one direction, whereas the pigment grains are drawn back on to the surface of the vase, to which they can then be anchored by the application of shellac; 30 volts D.C. for about half an hour is enough.

Another striking example of laboratory technique has been the mounting of Foraminifera from the limestone supports of classical fresco murals by means of thermo-plastic resins. Micro-sections can be made in this way from such friable material and preserved for archæological research in a convenient and permanent form.

At the beginning I referred briefly to the task of conservation in general. This is a matter which concerns the man of science very closely; and given the requisite knowledge for, and appreciation of, the task, he should be able to render valuable assistance. The experience gained during the War has been, or is being, turned to good account, and will assuredly influence future practice in gallery construction. With regard to the all-important subject of air-conditioning, it is essential to realize that any scheme must provide not only an appropriate environment for the exhibits, but also for the public. Repository surroundings during the war years can scarcely be considered as sure guides, since their only purpose was to take care of the valuables: the comfort and convenience of visitors did not arise. In short, we are now faced with a much more complex problem. Luckily, as regards relative humidity—the most vital single factor from the technical point of view—the human body is remarkably accommodating, much more so than with respect to temperature. Therefore we can provide a range of moisture-content well suited to the particular material, without the introduction of disagreeable features on that account. More trouble is likely to be met with in Britain in dealing with buildings architecturally unsuitable (as many are), and on account of our erratic climate.

In very general terms, the aim should be to prevent, or at least to diminish, the 'working' of substances like wood, textiles and so forth; or in the language of physics, to restrict the area of the hysteresis loop for wetting and drying to a minimum. This means keeping the moisture-content nearly level, which in its turn indicates the need for a constant relative humidity—say around 60 per cent for most exhibits.

More attention than hitherto will need to be paid to the so-called 'near-surface' effects. In other words, the relative humidity in the centre of a large room is not the same, even in the absence of temperature gradients, as that near the surface of objects placed in it. The reasons for this are complicated, but they point to the necessity of micro-determinations if trustworthy data are to be obtained for precious things, even if they are immersed in a nearly infinite reservoir of air of statistically satisfactory thermodynamic properties.

Given a return to something remotely approaching normality, there are good opportunities in the museum world: openings are not numerous, but they offer interesting careers with plenty of responsibility and scope for originality. But all on one condition. Natural science in such a context is ancillary to the fine arts in the literal sense of the word. She is art's serving maid; yet art must be sympathetic, apt to realize not only what science can do, but also what an objective philosophy can teach. Then all will be well. Such is our intention; and striving to attain it, not weighing our merits, but pardoning our offences, is, I take it, no more than our bounden duty and service.

OBITUARY

Dr. H. M. Tory

HENRY MARSHALL TORY died in Ottawa, Canada, on February 8, at the age of eighty-three. At the time of his last illness he was president of Carleton College, a post which he had filled from 1942 when he was instrumental in founding this institution of higher learning. At that time he had returned to active academic work after having enjoyed a few years of well-earned rest following a long life of high achievements. Thus once again his great talents for organisation were directed towards the establishment of yet another college. Early in his career he had contributed in no small measure to the founding of the University of British Columbia at Vancouver, and later the University of Alberta at Edmonton. He had directed the organisation of "Khaki College" in the First World War, and had been the first full-time president of the National Research Council of Canada. By virtue of his many high offices and as he was by natural bent a philosopher and an earnest educationist, he was widely recognized as one of Canada's most distinguished sons.

Born in Guysboro, Nova Scotia, on January 11, 1864, Tory was educated in the local academy and at McGill University, Montreal, where he graduated, a gold medallist in mathematics and physics, in 1890, and then continued on the staff as lecturer and associate professor, teaching mathematics and physics, and gaining a master's degree in 1896, and a doctorate in science, 1903.

From 1908 until 1928 he was president of the University of Alberta. His successors in office at that western institution have paid moving tributes to Dr. Tory's memory. Dr. R. C. Wallace, who succeeded him and is now principal of Queen's University, said: "He was a stalwart in the cause of world peace and intellectual co-operation, an able exponent of science in the modern world, and a warm friend to distressed peoples everywhere. There are not many men of Dr. Tory's stature in a generation, for he built the things that will endure"; and Dr. Robert Newton, president of the University of Alberta, expressed the feelings of many when he observed: "Dr. Tory was the greatest Canadian figure of his time in the field of education and scientific research".

Always actively interested in all matters concerning the welfare and progress of the Dominion and its people, Dr. Tory found himself chosen time and again to serve on royal commissions and boards established by various authorities to inquire into such diverse subjects as agricultural credits in Europe (1913) and in Canada (1923–24); coal classification (1923–35); the fruit industry in Nova Scotia (1930); and the coal industry (1936). He was a special commissioner from Canada to the Pan-Pacific Science Congress in Japan, 1926, and it was largely through his efforts that Government authorization was secured for the holding of the Fifth Pacific Science Congress in Canada in 1933. He organised the Congress and served as its president (1930–34). He served as colonel-director of educational services for the Canadian Overseas Forces during 1917–19.

His outstanding qualities as an educationist and leader in science and culture were recognized repeatedly by the award of honorary degrees and other distinctions. He received the honorary doctorate in laws from St. Francis Xavier College in 1906; from McGill in 1908; University of Toronto, 1927; Saskatchewan, 1928; Alberta, 1928; McMaster, 1932; British Columbia, 1932; Western Ontario, 1933; and a doctorate in civil law from Acadia, 1935. He was Governors' fellow of McGill University during 1905–8 and non-resident fellow 1908–15.

A fellow of the Royal Society of Canada, Dr. Tory held office as chairman of the physico-chemical section in 1927 and as president of the Society in 1940. He was a fellow of the Royal Historical Society and had a deep and abiding interest in history, in which subject he lectured at the University of Alberta. He was more especially interested in the history of philosophy and science, and conducted classes in these subjects at Carleton College. The Tory collection in the National Research Library was founded by his friends to commemorate his interest in this field of study.

In February 1923, Dr. Tory was appointed a member of the honorary advisory Committee for Scientific and Industrial Research, and named as chairman in October of the same year. He became director of the laboratories at Ottawa when these were still housed in temporary quarters, and president of the Council in 1927. Under his presidency, construction of the National Research Building was undertaken in 1930. He personally directed the planning of this fine structure, which was opened by Mr. Stanley (now Lord) Baldwin, at the time of the Imperial Economic Conference in Canada, 1932. Before he retired from the presidency of the Council in 1935, he had selected the original staffs for the laboratories and established the standards of ability and performance which enabled the institution to meet the challenge of war as it did.

Those with an intimate knowledge of Dr. Tory's work as president of the National Research Council will feel that his contributions to organised scientific and industrial research in Canada, which are acknowledged to-day, will loom larger still as the years lend perspective to the progress which Canada is making in this field. "An example and an inspiration, this man of the deepest integrity and the fullest public spirit will not soon be forgotten by the generation he served so admirably and so efficiently."

C. J. Mackenzie

NEWS and VIEWS

Royal Society: New Foreign Members

The following have been elected foreign members of the Royal Society:

Dr. E. J. Cartan, professor of geometry in the University of Paris and member of the Paris Academy of Sciences, distinguished for his fundamental work in the theory of continuous groups and in differential geometry;

Prof. P. Karrer, professor of chemistry in the University of Zurich, distinguished for his outstanding contributions to the chemistry of natural products, with special reference to the chemistry of the carotenoids, carbohydrates and vitamins;

Prof. H. C. Urey, professor of chemistry and director of the Institute for Nuclear Studies, University of Chicago, distinguished for his discovery of deuterium, for his investigations into the separation and properties of isotopes, and for the application of these discoveries in the development of methods for producing atomic energy;

Dr. Øjvind Winge, of the Carlsberg Laboratory, Copenhagen, distinguished for his many fundamental contributions to the cytogenetics of plants and animals.

Royal Naval Scientific Service: Sir Charles Wright, K.C.B., O.B.E.

Charles Seymour Wright, who has just resigned from the post of chief of the Royal Naval Scientific Service, was born in Toronto in 1887. He was educated at Upper Canada College and the University of Toronto. He won a Wollaston Research Studentship and an 1851 Exhibition Scholarship, with which he proceeded to Gonville and Caius College, Cambridge. He did research work at the Cavendish Laboratory during 1908–10. He joined Captain Scott as scientist to the Antarctic Expedition, 1910–13. After the return of the survivors of this expedition, he spent a year at Cambridge until the outbreak of war. He joined the Royal Engineers in 1914, first as wireless officer to the 5th Corps, during which period he earned the Military Cross. He later became O.C. Wireless of the 2nd Army, and for his services at this time was made a Chevalier of the Legion of Honour. He was decorated with the O.B.E. for his subsequent work in the Intelligence Division of the General Staff.

After he had been demobilized, he became senior assistant to Mr. F. E. (later Sir Frank) Smith, then director of the newly formed Department of Scientific Research and Experiment at the Admiralty. In the same service he was appointed superintendent of the Admiralty Research Laboratory, Teddington, in 1929, a post which he held for five years. He became director of scientific research at the Admiralty in 1934 and carried throughout the Second World War the high responsibilities of this director's position as well as during the rearmament period preceding it. With the formation of the Royal Naval Scientific Service in 1946 and the reorganisation of Admiralty arrangements for the direction of scientific research, he was appointed first chief of the Service. He was made a C.B. in 1937 and a K.C.B. in 1946. All who served under him received help and guidance from a most genial personality. He will be greatly missed by his colleagues and by the scientific workers with whom he came in contact elsewhere.

Mr. F. Brundrett, C.B.

The Admiralty has announced that Mr. F. Brundrett has been appointed chief of the Royal Naval Scientific Service in succession to Sir Charles

Wright. Mr. Brundrett went to Sidney Sussex College, Cambridge, and obtained first-class honours (Wrangler) in the Mathematical Tripos. During 1916–19 he served in the R.N.V.R., and then was appointed to the scientific staff of H.M. Signal School, where he served in various capacities until 1937, his most outstanding original technical work being on the propagation of short wireless waves and in the organisation of world-wide propagation trials. In 1937 he was transferred to the Scientific Research and Experiment Department, Admiralty, as principal scientific officer, where a sequence of rapid promotions led to his becoming a deputy director of scientific research in 1942. In 1946 Mr. Brundrett was appointed assistant to the chief of the Royal Naval Scientific Service for the reconstruction period.

At the start of the Second World War, as many hundreds of scientific men throughout Great Britain will know from personal experience, Mr. Brundrett accomplished with great success a prodigious task in organising and recruiting a vast expansion of the Navy's scientific staff, and in the radar research branches of the other Services. He was throughout the War particularly prominent in the organisation and administration of radio valve research for the Services. He was honoured with the award of the C.B., in recognition of his war-time work, in the New Year Honours, 1946. Mr. Brundrett has a farm in Hampshire where he has achieved great success in the breeding of pedigree poultry and Red Poll cattle.

Physics at King's College, London: Prof. C. A. Coulson

Dr. C. A. Coulson, recently appointed to the University chair of theoretical physics at King's College, London, is among the foremost workers in Great Britain on the wave-mechanical side of quantum theory. Although Coulson's research papers cover a very wide range of interests (he collaborated with Lea and Haines in early work on the action of radiation on bacteria and has also made contributions to the theory of liquids and solutions), the great bulk of his published work deals with the application of wave-mechanics to the theory of molecular structure. It has been concerned both with the determination of accurate wave-functions for simple molecules and molecular ions and with the necessarily more approximate treatment of large organic molecules. An extensive series of papers in collaboration with W. E. Duncanson deals with the rather neglected field of momentum distribution functions and the related Compton-line profiles.

In the theoretical treatment of large unsaturated molecules, Coulson uses the method of molecular-orbitals originally due to Hückel and first developed in Britain by Prof. (now Sir John) Lennard-Jones at Cambridge. Coulson has used this method for a great variety of problems, from the computation of the bond-lengths of such a molecule as coronene to a calculation of the electrical conductivity of pure graphite. Recently, at Oxford, Coulson and his co-workers have made considerable advances towards an understanding of the effects of substituents in molecules and a general theory of chemical reactivity. In addition to his research papers, Dr. Coulson has also written text-books on the more elementary and classical aspects of mathematical physics. He has a well-deserved reputation for his kindly and helpful encouragement of younger research workers.

Food and Agriculture Organisation: Production and Research

Dr. G. Scott Robertson, Permanent Secretary of the Ministry of Agriculture for Northern Ireland, has been seconded for a period of six months to take up the post of director of agricultural production and research under the Food and Agriculture Organisation of the United Nations. Dr. Scott Robertson went to Northern Ireland in 1922 and held the dual post of professor of agricultural chemistry in the Queen's University of Belfast and senior research officer of the Ministry of Agriculture. It was during this period that he continued the now classic work on phosphatic fertilizers which he had been conducting for several years in Essex while head of the Agricultural Chemistry Department of the East Anglian Institute of Agriculture. At the same time Dr. Scott Robertson started a series of investigations on the mineral requirements of farm livestock, paying particular attention to those of poultry. This work was carried out in close collaboration with Sir John Boyd Orr, who was then director of the Rowett Research Institute. In 1928, Dr. Scott Robertson became chief inspector of the Ministry of Agriculture for Northern Ireland, and later was appointed permanent secretary when Dr. J. S. Gordon retired. For many years Dr. Robertson has acted as assessor on the Agricultural Research Council and United Kingdom delegate to the meetings of the Imperial Agricultural Bureaux. Thus he brings to his new work many years experience in agricultural research, coupled with administrative knowledge gained as head of a department the energies of which have been devoted to the task of production at the highest possible level for more than seven years.

Research in the Region between Subsonic and Supersonic Speeds

There is a large gap in our knowledge which must be bridged before we can take decisive steps from present aircraft subsonic speeds to supersonic speeds. There is first of all the question as to what happens when actually passing through the range of speed about that of sound. It is known that we must expect a steep rise of drag in this region, but we have no quantitative information. There is the further question of change of trim and stability in level flight as one passes from subsonic to supersonic speeds. There are other questions of aerodynamic and structural significance, and the whole problem is rather complex. Normally one would expect to get a large part of this information from wind tunnels, and although the capabilities of existing wind tunnels will be used to the limit, nobody knows how to design or use a practicable wind tunnel at or about the speed of sound. The phenomenon known as 'choking' and the effect of wall interference prohibit the use of tunnels for model tests at Mach numbers between about 0·9 and 1·15. This is the main reason for going into the air, and a series of experiments has been planned to use flying model aircraft launched from a great height from another aircraft and powered by rockets. This form of propulsion should enable the models to be driven through the speed-range of that of sound to various supersonic speeds.

The models will be fitted with instruments, and a six-channel telemetering system will transmit readings continuously to the ground, giving information on speed, height, Mach number, drag, lift coefficient and longitudinal trim. Radar observations will also be made on the flight path. All this involves a new research technique, and early experiments will be mainly concerned with perfecting it. Step by step it is hoped to reach the position where enough information will be available to design a supersonic radio-controlled aircraft. The rocket thrust is about 850 lb. acting for some 70 sec. An auto-pilot controls the model in pitch and roll. It is proposed to release the model at 36,000 ft. from a Mosquito aircraft, when the controls will operate to cause it to glide down to 35,000 ft. The rocket motor will then be switched on to accelerate the model in roughly level flight, at this height, to an estimated Mach number of about 1·3. When the fuel is all burnt the model will decelerate, its speed passing through that of sound to subsonic velocity; so a double chance will occur of getting readings in the critical transonic region before the automatic controls operate to crash the model into the sea. The models have been designed by Mr. B. N. Wallis, of Vickers-Armstrong, and made there in collaboration with the Royal Aircraft Establishment, which is responsible for the conduct of these experiments. The experiments should start in about a month's time off the Scilly Isles.

Chemistry at the University of Sheffield

The Staveley Coal and Iron Co., Ltd., near Chesterfield, has decided to make a gift of £50,000 to the University of Sheffield in order to promote the furtherance of research within the University and especially in the Department of Chemistry. The Company, which is concerned with the production of iron, caustic soda, chlorine, hydrochloric acid, chlorates, aniline and a wide range of basic coal-tar products, takes the view that encouragement of free chemical research in universities must, in the long run, benefit both the Company and industry as a whole, and believes that the connecting of industrial development with academic discovery is essential for national prosperity. Its gift to Sheffield is most opportune, as the provision of a new Department of Chemistry is one of the most urgent parts of the post-war plans of the University's extension scheme. It is intended to replace the existing laboratories, built in 1905, by an entirely new department which will be close to the present building of the University in Western Bank. The new building has been designed to provide adequate space for all the work in the Department when the University attains its projected number of 3,000 full-time students in all faculties, and adequate research facilities will be provided for investigations in analytical, inorganic, physical and organic chemistry. It is estimated that the cost of the erection of the new Department will exceed £400,000, and it is proposed that the research laboratories therein should be named the "Staveley Laboratories".

A New Rat Poison

To the well-known list of rat poisons, such as arsenic trioxide, red squill and zinc phosphide, the last years of the War added another, α-naphthathiourea. Dr. C. P. Richter, of Baltimore, was responsible for showing that its toxicity to *Rattus norvegicus* was high (A.L.D./50, 10 mgm. per kilo body-weight). Somewhat extravagant claims were made for its effectiveness when applied as a direct bait. In none of the field tests were accurate censuses made of the rat population before treatment. Prolonged and detailed experience in Great Britain at the Bureau of Animal Population has shown that knowledge obtained by bait census is essential before field trials are undertaken. The use of α-naphthathiourea as a dusting powder, however, opened up possibilities of a new method of application, but its usefulness depended upon the safety factor involved. Toxicity tests made on other animals showed an enormous range of sensitivity. *R. rattus*, the ship or black rat, had an A.L.D./50 of 250+ mgm. per kilo body-weight, more than twenty-five times that for *R. norvegicus*, while *Mus musculus*, the house mouse, had an A.L.D./50 of 80–90 mgm. per kilo body-weight. These data showed that it was impossible to predict a safety-level from one species to another. Consequently, although tests on monkeys (*Macacus* sp.) showed a high resistance, it was dangerous to assume that man was equally immune. Dusting application was therefore not advised in Great Britain until more information was available.

Used in baits, following the pre-baiting technique worked out by the Bureau of Animal Population, α-naphthathiourea gave results as good as those with arsenic and zinc phosphide, namely, 90 per cent kills; used as a direct bait without prebaiting, some successes were met with, but also the usual failures (for example, 40 per cent kill). Since the failure to exterminate rats is largely due to the hit and miss nature of direct baiting which has been employed for so long, there seemed no grounds for regarding α-naphthathiourea as any considerable advance on the well-established poisons. α-Naphthathiourea is now being marketed by the Rodmill Chemical Co., Ltd., as 'Antu', containing 2 per cent of the active principle. As a ready-to-use compound bait, 'Antu' must be classed with the direct baits which do not allow the purchasing public to pre-bait and ensure success. It is also being recommended as a dusting powder for use in rat runs, on beams and elsewhere "inaccessible to domestic animals"—places which may be hard to find. From the point of view of rodent control, it is to be regretted that α-naphthathiourea is not being marketed at a 20 per cent concentration in an inert medium and so allowing the public to obey the recommendations of the Infestation Division of the Ministry of Food to pre-bait before poisoning, a technique worked out by the Bureau of Animal Population during the War, which has proved itself again and again to be the only really certain way of exterminating rats.

Exhibition of Applied Photography

An Exhibition of Applied Photography arranged by Kodak Ltd. at Australia House, Strand, London, was opened on May 6 by Prof. E. N. da C. Andrade. The exhibits illustrate a very wide range of industrial and commercial applications of photography, the applications being illustrated by photographs, diagrams and in some cases demonstrations. Photography received a fair amount of publicity during the War, particularly on account of its obvious importance for air reconnaissance. There were, however, many other applications less spectacular, but nevertheless of great value, many of which are illustrated in some form in this exhibition. Most of these applications have come to stay and will play a useful part in peace-time industry. The range covered by the exhibition is very wide; on the spectacular side is a full-sized radiograph of a 'Jeep' to set against the purely utilitarian micro-copying of documents. Other exhibits include industrial radiography, gamma radiography, stereoscopy, photography in education, colour reproduction and the reproduction of drawings on metal. Among the most interesting exhibits are the 16-mm. projectors showing continuously running films of mechanical and manual operations, some in slow motion, to illustrate how an analysis of the motion can be used to speed up, or reduce fatigue in, the operation. Most of the exhibits illustrate industrial applications of photography, and the whole provides an interesting collection well worth a visit. The exhibition remains open until May 16.

Congresses

Radiation Chemistry and Photochemistry

A SYMPOSIUM on radiation chemistry and photochemistry is being arranged at the University of Notre Dame during June 24–27. Particulars can be obtained from Prof. Milton Burton, Department of Chemistry, University of Notre Dame, Notre Dame, Indiana.

Spectroscopy

THE Groupement pour l'Avancement des Méthodes Spectrographiques is organising a general meeting to be held during June 23–25 at the Laboratoire Central de l'Armement, 1 place Saint-Thomas d'Aquin. Two sessions will be devoted to emission spectroscopy and the third more particularly to colorimetric methods of analysis. Particulars can be obtained from the offices of the Group at the place of meeting.

Aeronautics

AN Aeronautical Congress will be held in London during September 3–6, at which papers will be read, followed by discussions, on the technical aspects of aviation. The Congress is being arranged by the Royal Aeronautical Society in close co-operation with the Institute of the Aeronautical Sciences of America, and about half the papers will be by American authors. A tentative programme of some twenty papers has been arranged under the following sections: aerodynamics, structures, power plants, stability and control, air-worthiness and safety, high-altitude flight, telemetering, helicopters and light (personal) aircraft. A detailed programme will be available shortly from the Royal Aeronautical Society.

Physical Chemistry

AN advanced course in physical chemistry for graduates in industry, colleges of technology and schools, will be held at the University of Leeds during August 25–September 5. The main topics will be the wave nature of matter in chemistry; molecular structure and chemical reactions; the arrangement and structure of molecules in the solid state. Particulars of the course and forms of application may be obtained from the Director of Extra-Mural Studies, The University, Leeds 2.

Cytology

THE sixth international Congress of Experimental Cytology will meet in Stockholm during July 10–17. The Congress will consist of a series of symposia on (*a*) chemical constituents of the cell; (*b*) submicroscopic structure of protoplasm (including viruses); (*c*) nuclear and cytoplasmic interactions; (*d*) cell metabolism; (*e*) development, growth and differentiation. General surveys will be given, followed by discussions and short papers relating to the above subjects. The organising committee is prepared to arrange accommodation. Particulars relating to the Congress can be obtained from the secretaries, Prof. T. Caspersson and H. Hydén, Karolinska Institutet, Institute for Cell Research, Stockholm.

Announcements

A MEETING in memory of Paul Langevin has been arranged by the Society for Visiting Scientists, the Association of Scientific Workers and the World Federation of Scientific Workers, to be held on May 25 at 7.45 p.m. at the Beaver Hall, Garlick Hill, London, E.C.4. Sir Henry Tizard will take the chair, and the speakers will include M. Pierre Biquard, of the French Commissariat of Atomic Energy and the Paris School of Physics and Chemistry, Sir Harold Spencer Jones, Sir George Thomson and Prof. J. D. Bernal.

DR. LAWRENCE L. LACHAT, senior fellow at the Mellon Institute, Pittsburgh, Pa., has resigned to accept a new position with the Chemical Research and Development Department, Armour and Co., Chicago, Ill., where he will be in charge of the development of new biochemicals which largely became available as a result of war-time research between Armour and Co. and the U.S. Office of Scientific Research and Development.

RECENT publications of the Federal Security Agency, U.S. Office of Education (Washington: Gov. Printing Office), are of interest as showing the heed paid by the United States as to the state of education in South America. Three bulletins at hand deal with Costa Rica, Colombia and Peru, and all of them merit attention by students of comparative education.

A FULL report of the two-day conference on "Industry and Research" arranged by the Federation of British Industries in March, 1946 (see *Nature*, **157**, 684; 1946), has now been published by Sir Isaac Pitman and Sons, Ltd. (London, 1946. 10*s*. 6*d*. net). It includes a preface by Sir Clive Baillieu, and, in addition to the papers presented, the addresses of the various chairmen and reports of the discussions at the sessions on scientific research and production, scientific research and industrial expansion and the application of research in industry.

WITH the financial help of private individuals and of the Juan Bautista Sauberan Foundation of Buenos Aires, an institute for research in fundamental branches of medicine has been organised in Córdoba, Argentina (25 de Mayo 1122); it will be known as the Instituto de Investigación Médica para Promoción de la Medicina Científica. The staff includes, among others, Dr. Oscar Orias (director), Dr. Enrique Moisset de Espanés and Dr. Inés L. C. de Allende. All three formerly held travelling fellowships of the Rockefeller Foundation; Dr. Orias working at Western Reserve and Harvard Universities with Profs. Carl J. Wiggers and the late Walter B. Cannon; Dr. Moisset de Espanés at Harvard University with Prof. Otto Krayer, and Dr. de Allende in Rochester, N.Y., and New York, with Profs. George W. Corner and Efrain Shorr. They held posts in the Institute of Physiology in the Medical School of the University of Córdoba, but resigned after the recent changes in the administration of the universities of Argentina. The new Institute is a private institution; its main activity will be research in endocrinology, pharmacology and physiology of the circulation of the blood.

ERRATUM. In the penultimate paragraph of "Synthesis of Methionine and Similar Amino-Acids" by J. R. Catch *et al.* (*Nature*, April 26, p. 578), for "α-amino-γ-thio-1-γ-methyl-*n*-valeric" read "α-amino-γ-thiol-γ-methyl-*n*-valeric".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

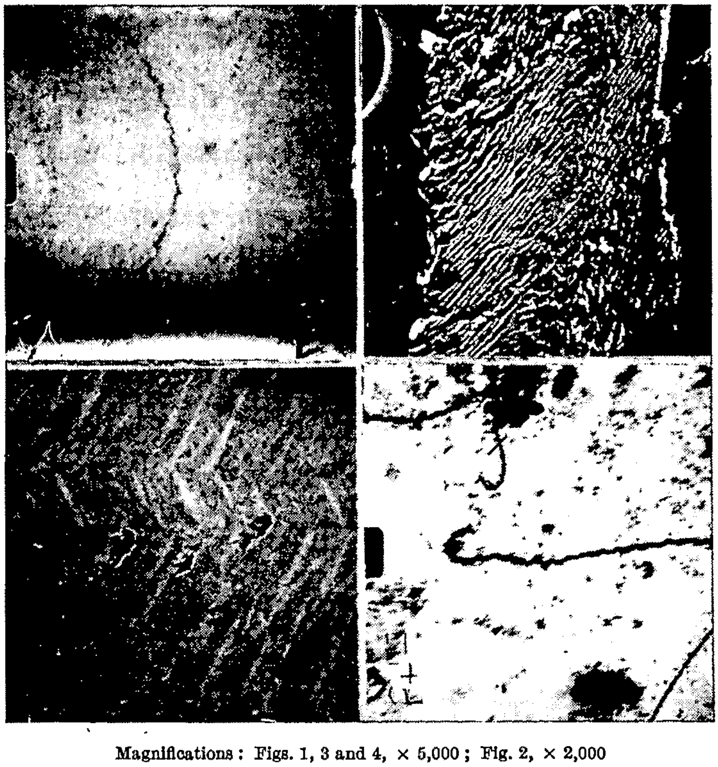
A Methyl Methacrylate–Silica Replica Technique for Electron Microscopy

Barnes, Burton and Scott[1] have described a modified polystyrene–silica replica technique for the study of organic surfaces; but owing to the high temperatures (130° C.) involved in the formation of the intermediate replica, their method is unsuitable for water-containing substances. They suggest, however, 'that some plastics such as isobutylmethacrylate are sufficiently thermoplastic at temperatures below 100° C. to give the necessary resolution without total drying of the specimen.

We have used a method of actual polymerization from the liquid monomer of methyl methacrylate poured over the surface of the specimen, and by it obtained electron-micrographs of silica replicas of metallic surfaces, blood cells, *Leptospira* and other materials. The intermediate replica may be formed at any convenient low temperature—even at room temperature or below—and no pressure is required, since the monomer is applied as a liquid, the viscosity of which is entirely under control. Thus it is only necessary to remove any surface water from the specimen to be examined.

In the case of metallic surfaces, the method has, in general, no advantage over the polystyrene-thermoplastic technique, but may be useful in the case of metals which oxidize very readily. Its importance is obvious in the examination of biological material.

Figs. 1, 2 and 3 are examples of the electron micrographs, methyl methacrylate being used for the intermediate replica in each case. Fig. 1 was obtained from *Leptospira canicola* dispersed on a glass slide, fixed in osmic acid vapour and superficially dried; Fig. 2 shows twinning and grain boundaries in thermally etched silver, and Fig. 3 shows fine structure in pearlite steel. For comparison with Fig. 1, Fig. 4 is an electron-micrograph of *Leptospira canicola* obtained with the organism mounted on a nitrocellulose film in the electron microscope. The close similarity between Figs. 1 and 4 suggests that *Leptospira* is not changed by the electron bombardment and drying which it undergoes in the electron microscope.



Magnifications: Figs. 1, 3 and 4, × 5,000; Fig. 2, × 2,000

To obtain the methyl methacrylate replica, methyl methacrylate monomer stabilized with 0·1 per cent hydroquinone is treated in the following way (the stabilized monomer may be obtained from I.C.I. Ltd. under the trade name of 'Kallodoc'). The method is very similar to that used by workers in other fields.

Step 1. The hydroquinone is removed in caustic soda by shaking 100 c.c. of the stabilized material with 20 c.c. of 20 per cent (w/v) aqueous caustic soda in a separating funnel and running off the brown bottom layer. The methyl methacrylate is washed with two lots of distilled water in a separating funnel, the bottom layer being run off in each case, and it is dried by standing for a night over about 5 gm. of anhydrous calcium chloride in a beaker. This destabilized liquid may be kept in a cool dark place for some months.

Step 2. About 5 c.c. of the destabilized methyl methacrylate is heated at 90° C. for about half an hour with 0·003 gm. of benzoyl peroxide. The time of heating may be varied to give a more or less viscous liquid. A lower viscosity will give a better resolution through being able to enter the small interstices of the surface, but will take considerably longer to polymerize on the specimen.

Step 3. (*a*) The treated methyl methacrylate from (2) is poured over the specimen and allowed to 'set' at 60° C. overnight; or (*b*) the treated methyl methacrylate from (2) is allowed to cool to room temperature (or below if required) and is then poured over the specimen and allowed to 'set' at this temperature.

The methyl methacrylate is now teased from the specimen with a razor blade and is coated with silica as described by Heidenreich and Peck[2] in the polystyrene–silica replica technique. The method of removing the silica is also analogous to that used in the polystyrene–silica method, the only difference being that the methacrylate is dissolved away in toluene and the silica films washed in clean toluene.

Methyl methacrylate has an advantage for this replica technique in that pieces of the body investigated, which might stick in the methacrylate, may be removed in dilute acids or dilute alkali without impairing the replica. *Leptospira*, for example, dissolves in 5 per cent (w/v) nitric acid.

A silica replica is also preferred to a 'Formvar' or collodion replica, this being also found by other workers[3].

Dr. J. A. H. Wylie of the Sir William Dunn School of Pathology, Oxford, prepared and dispersed the *Leptospira*, and Miss D. M. Williams assisted with all the electron-microscopy work. The work was started at the Clarendon Laboratory, Oxford, and continued at the Atomic Energy Research Establishment, and was done with an R.C.A. *EMC* console type electron microscope. It is published by permission of the Director, A.E.R.E.

A. F. Brown
Cavendish Laboratory, Cambridge.

W. M. Jones
X-Ray Group, A.E.R.E., Harwell.
Feb. 14.

[1] Barnes, R. B., Burton, C. J., and Scott, R. C., *J. Appl. Phys.*, **16**, 730 (1945).

[2] Heidenreich, R. D., and Peck, V., *J. Appl. Phys.*, **14**, 23 (1943).

[3] Heidenreich, R. D., and Matheson, L. A., *J. Appl. Phys.*, **15**, 423 (1944).

Optimum Disturbing Field for Synchrotron Beam Ejection

Several methods have been suggested[1,2,3] for using disturbing magnetic fields to eject an electron beam from a synchrotron or betatron. Important differences exist in these methods in the angular distribution of these disturbing fields. Thus the 'orbit expansion' method[1,2] effectively applies a sudden decrease of field over the whole 360° of annulus, while the '+ − field' method[3] decreases the field over 180° of annulus, while increasing it over the other 180°. The considerations outlined in this communication lead to the suggestion of an 'optimum step field', that is, a disturbing field of angular length such that the required beam displacement is obtained with minimum reactive power in the ejector field coil.

Consider the motion of an electron of energy $E = 300\, H_0 r_0$ in the magnetic field:

$$\left.\begin{array}{l} H = (H_0 - \Delta H_0)\,(r/r_0)^{-n} \text{ for } -\theta_1/2 \leqslant \theta \leqslant \theta_1/2 \\ H = H_0\,(r/r_0)^{-n} \text{ elsewhere.} \end{array}\right\} \qquad (1)$$

The decrease in field, ΔH_0, causes an increase in equilibrium orbit radius of Δr_0, where, letting $K = \sqrt{1-n}$,

$$K^2\, \Delta r_0/r_0 = \Delta H_0/H_0. \qquad (2)$$

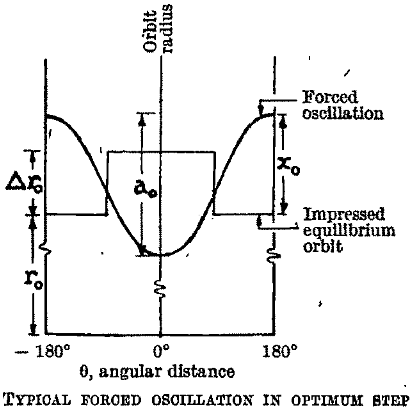


Fig. 1. Typical forced oscillation in optimum step field

Provided ΔH_0 is introduced so slowly that free oscillations are not excited, the motion of the electron is a forced one, repeating itself each revolution. Its maximum radial displacement x_0 from r_0 is given by

$$x_0 = \Delta r_0 \sin \tfrac{1}{2}K\theta_1/\sin K\pi\,; \qquad (3)$$

and the overall amplitude of the forced oscillation by

$$a_0/x_0 = (\sin K\pi)\,(\tan K\pi/2 - \tan K\theta_1/4). \qquad (4)$$

Now the reactive power required to build up the disturbing field, ΔH_0, in a fixed time is proportional to $\theta_1(\Delta H_0)^2$ and, therefore, using (2) and (3) we have, for the power required to produce a given x_0,

$$P = \tfrac{1}{2} P_1 (\sin^2 K\pi)\,(\theta_1/\sin^2 \tfrac{1}{2} K\theta_1), \qquad (5)$$

where P_1 is a constant. P is minimum when

$$K\theta_1 = 133^\circ\, 34', \qquad (6)$$

which gives for the minimum power:

$$P \doteq 1{\cdot}37\, P_1 (\sin^2 K\pi)/K. \qquad (7)$$

It will be seen that (6) defines an angle $\theta_1 \leqslant 360^\circ$ provided $0{\cdot}37 \leqslant K \leqslant 1$. If $0 \leqslant K < 0{\cdot}37$, however, 360° must be taken as the optimum attainable value for θ_1, and (7) is replaced by

$$P = \pi P_1. \qquad (8)$$

To assess the value of the above considerations, the power required to produce the same x_0 has been calculated for two other ejection methods. For the 'orbit-expansion' method we have, clearly, as in (8)

$$P' = \pi P_1 \;\ldots\; 0 \leqslant K \leqslant 1; \qquad (9)$$

while, for the '+ − field' method, the equivalent of equation 3 is $x_0 = \Delta r_0\,(\sec \tfrac{1}{2} K\pi - 1)$, which leads to

$$P'' = (4\pi/(\sec \tfrac{1}{2}K\pi - 1)^2) P_1 \;\ldots\; 0 \leqslant K \leqslant 1. \qquad (10)$$

These powers are compared in Fig. 2, from which the advantage of an optimum step-field is clear.

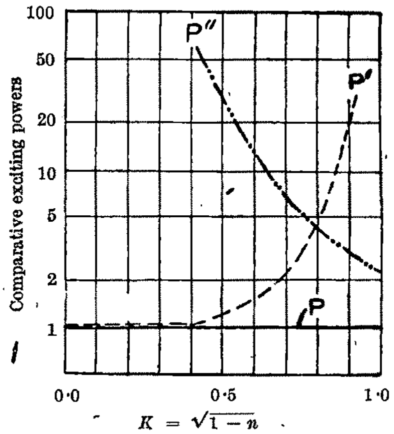


Fig. 2. Comparative powers for given displacement

In most cases, reactive power considerations will be the only important ones and the optimum step field will be used. However, in the particular case of using an external injection gun and extractor (say, a magnetic shunt[1]), both in the plane of the electron orbits, the forced oscillations are used to clear the injector during extraction. It will be seen from equations 4 and 6 that the overall amplitude of the forced oscillations, a_0, is $\geqslant x_0$ provided $1 \geqslant K \geqslant 0{\cdot}68$. In this range, therefore, the optimum step field gives the same clearance as the '+ − field', for in the latter case, although a_0 is always equal to $2x_0$, the undisturbed equilibrium orbit only clears the extractor by x_0. For $0 \leqslant K < 0{\cdot}68$ the clearance with the optimum field method is less than with the '+ − field' method, for example, at $K = 0{\cdot}55$ it is $0{\cdot}5x_0$. In general, however, sufficient clearance can be obtained still maintaining high power efficiency, by using a step field of less than optimum length.

This work was carried out by the Atomic Energy Research Establishment Group at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Dr. J. D. Cockcroft for permission to publish these results.

F. K. GOWARD
J. DAIN
Telecommunications Research Establishment,
Ministry of Supply,
Malvern, Worcs.
Feb. 24.

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[1] Skaggs, Almy, Kerst and Lanzl, *Phys. Rev.*, **70**, 95 (1946). Kerst, *Rev. Sci. Instr.*, **13**, 387 (1942).

[2] Crittenden and Parkins, *J. Appl. Phys.*, **17**, 444 (1946).

[3] Clark, Getting and Thomas, *Phys. Rev.*, **70**, 562 (1946).

Structure of Graphite

THE recent communication in *Nature*[1] by J. Gibson directing attention to new extra lines in the X-ray powder diffraction pattern of graphite led us to re-examine a number of photographs of purified natural and artificial graphites taken some time ago. There appeared to be no extra lines in the positions observed by Gibson, although there were some exceedingly faint ones in other positions.

It seemed to us important to attempt to test the validity of Gibson's findings, because, if his extra lines were genuine, certain important modifications of the structure of graphite would be necessary. Our conception of the variations which may possibly occur in the graphite structure would permit the observation of weak extra lines at angles higher than that of the $10\bar{1}0$ reflexion from hexagonal graphite but would preclude any others, unless periodic inclusions are present. Now Gibson's strongest extra lines are precisely these 'forbidden' low-angle (high-spacing) deflexions.

If these structural variations are not present in appreciable proportions, the origin of the extra lines must be connected with the presence of impurities either in the specimen or in the spectrum of the X-radiation used in producing the pattern. To test the first possibility, Dr. Gibson very kindly sent us some of his purified (but not heat-treated) Ceylon graphite; its ash content was stated to be 0·07 per cent. A photograph was taken of this specimen, supported in a flat, 0·03-mm. thick, 'Cellophane' holder in an 11·5-cm. diameter Seeman–Bohlin focusing camera using cobalt $K\alpha$ radiation reflected from a bent quartz monochromator. No extra lines were seen other than weak rhombohedral lines. We also took ordinary Debye–Scherrer powder photographs in a 9-cm. camera using copper $K\alpha$ radiation reflected from a plane pentaerythritol crystal, and again observed no 'extra' lines other than those corresponding to the rhombohedral structure.

This suggested that the filtered radiation used by Gibson probably contained substantial amounts of wave-lengths other than cobalt $K\alpha$, and a more detailed examination of the θ values given by Gibson in his note confirmed this supposition. When the wave-lengths of the first six lines were calculated from the Bragg relationship assuming reflexion from the 0002 planes, it was seen that they agreed well with wave-lengths of various metals; reflexion of these same radiations from other graphite planes accounted for the remaining ten lines.

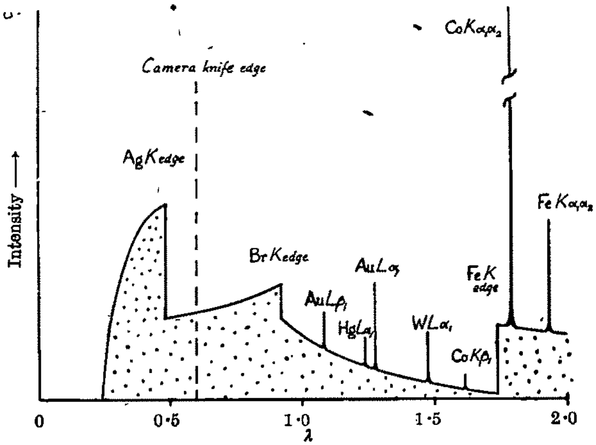
Measurements taken from Gibson's table		Impurity† wave-length		Corresponding‡ wave-length	
Line No.	$\theta°$	λ (in kX.)	Reflected from	λ (in kX.)	Element series
* 1	9·38	1·091	0002	1·081	Au$L\beta_1$
* 2	10·66	1·238	0002	1·239	Hg$L\alpha_1$
* 3	10·98	1·275	0002	1·274	Au$L\alpha_1$
* 4	12·68	1·469	0002	1·473	W$L\alpha_1$
* 5	13·96	1·615	0002	1·617	Co$K\beta_1$
* 6	16·79	1·934	0002	1·934	Fe$K\alpha_1\alpha_2$
7	17·81	1·240	$10\bar{1}1$	1·239	Hg$L\alpha_1$
8	18·40	1·279	$10\bar{1}1$	1·274	Au$L\alpha_1$
9	21·32	1·474	$10\bar{1}1$	1·473	W$L\alpha_1$
*10	22·44	1·278	0004	1·274	Au$L\alpha_1$
11	28·41	1·929	$10\bar{1}1$	1·934	Fe$K\alpha_1\alpha_2$
12	31·39	1·279	$11\bar{2}0$	1·274	Au$L\alpha_1$
13	33·71	1·282	$11\bar{2}2$	1·274	Au$L\alpha_1$
14	36·82	1·472	$11\bar{2}0$	1·473	W$L\alpha_1$
15	39·72	1·476	$11\bar{2}2$	1·473	W$L\alpha_1$
16	67·30	1·472	$21\bar{3}1$	1·473	W$L\alpha_1$

* Doublet.

† Calculated from the values of the cell dimensions of graphite obtained by Nelson and Riley[4].

‡ Taken from Siegbahn's "Spectroscopy of X-rays" (Oxford University Press, 1925).

It appears clear from the table that Gibson's extra lines can be attributed to the presence of small amounts of iron, gold, mercury and tungsten in the cobalt target plating. The fact that only the lines arising from the basal plane reflexions are doubled lends support to this conclusion, as these reflexions only are usually doubled in ordinary powder photographs of graphite[2]. It will be noticed that a number of lines which should be present have apparently not been observed by Gibson. In most cases this is due to their coincidence or close proximity with either strong cobalt $K\alpha$ lines (Au$L\alpha_1$ from $21\bar{3}1$, W$L\alpha_1$ from 0004, Fe$K\alpha$ from 0004, $11\bar{2}2$ and $11\bar{2}0$, Hg$L\alpha_1$ from $11\bar{2}0$ and $21\bar{3}1$) or with the impurity radiation lines themselves (Hg$L\alpha_1$ from 0004 and $11\bar{2}2$). The iron filter used to reduce the intensity of the cobalt $K\beta$ does not appear to have been chosen of optimum thickness. Moreover, the use of an aluminium screen in front of the photographic film is a practice which accentuates the effects of harder radiation[3] and does not in general reduce 'back-ground scatter'. The effect on the photographic films of the wave-length/intensity distribution of the radiation used is probably something like that shown in the accompanying figure.



PROBABLE EFFECTIVE SPECTRAL DISTRIBUTION OF THE RADIATION USED

For most X-ray diffraction work, carefully filtered radiation is perfectly adequate. However, it is clear from this work that for the detection of second-order effects, slight amounts of extra phases, or for the examination of disordered or amorphous substances, the use of crystal-reflected radiation is essential, if the introduction of spurious detail into the diffraction pattern is to be avoided.

It is interesting to observe here that with the ordinary 19-cm. diameter powder camera, together with a specimen rod of a pure substance giving well-spaced strong reflexions, it is a comparatively simple matter to test the purity of the filtered X-ray beam.

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(at the Crystallographic Laboratory,
Cavendish Laboratory,
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D. P. Riley
Crystallographic Laboratory,
Cavendish Laboratory,
Cambridge.

[1] Gibson, J., *Nature*, **158**, 752 (1946).

[2] Nelson, J. B., and Riley, D. P., *Phil. Mag.*, **36**, 711 (1945).

[3] Gregg, R. Q., and Gingrich, N. S., *Rev. Sci. Instr.*, **11**, 305 (1940).

[4] Nelson, J. B., and Riley, D. P., *Proc. Phys. Soc.*, **57**, 477 (1945).

A RECENT communication by Gibson[1] sought to show that X-ray powder photographs of graphite contained 'extra' reflexions that could not be explained on the basis of the co-existence of the hexagonal and rhombohedral structures described by Lipson and Stokes[2]. It is of some importance that the crystal structure of graphite should be correctly specified[3], and, because of our experience in examining by X-ray methods graphites from many different sources, we have thought it useful to investigate the validity of the observations made by Gibson. Besides the particular problem of the structure of graphite, there are also involved some questions of X-ray technique on which comment appears called for.

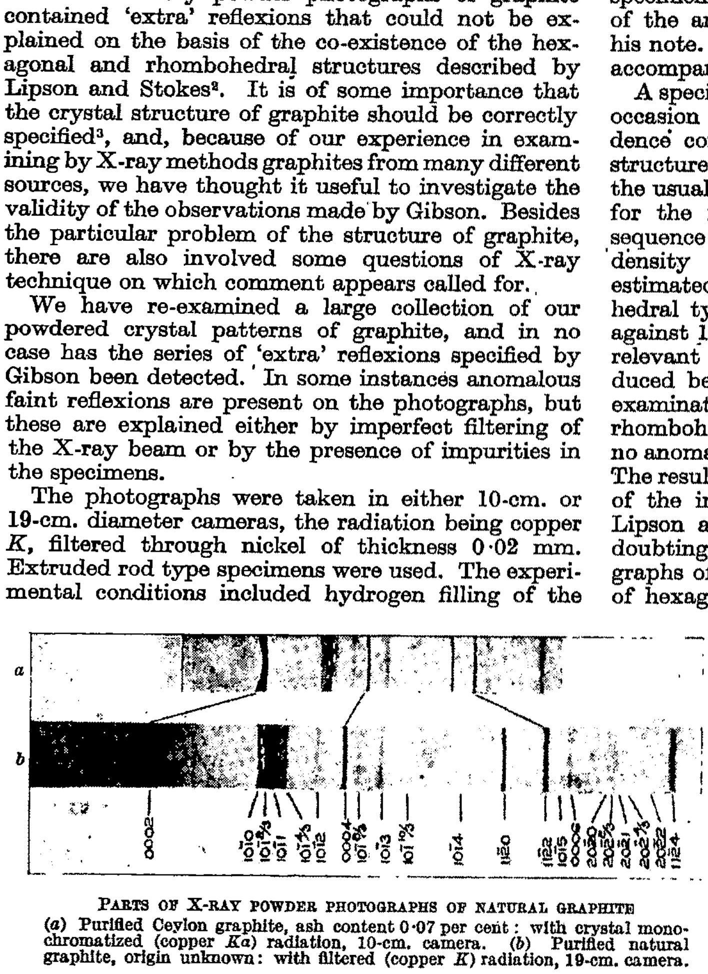
We have re-examined a large collection of our powdered crystal patterns of graphite, and in no case has the series of 'extra' reflexions specified by Gibson been detected. In some instances anomalous faint reflexions are present on the photographs, but these are explained either by imperfect filtering of the X-ray beam or by the presence of impurities in the specimens.

The photographs were taken in either 10-cm. or 19-cm. diameter cameras, the radiation being copper *K*, filtered through nickel of thickness 0·02 mm. Extruded rod type specimens were used. The experimental conditions included hydrogen filling of the camera to reduce background scatter, but not an aluminium screen, as it is considered that no advantage is to be gained from the use of even a thin screen with such materials as graphite. The photographic density of the films appeared in every way comparable with that of Gibson's, with the background clear enough to provide favourable conditions for detection of weak lines, should they occur. The change from cobalt to copper radiation cannot be regarded as significant, for we see no reason to suppose that reflexions appearing with one radiation are likely to be suppressed when the other is used. Most of the patterns showed a faint 0002β line, attributable to the imperfect filtering action of the nickel absorbing screen; the identification of this line is a simple matter.

In order that we could rule out the possibility that our samples of graphite did not include every variant, Dr. Gibson kindly sent us specimens of two of the powders which he had used. One of them was the purified natural graphite with ash content 0·07 per cent; the other was an artificial graphite of ash content 0·05 per cent. We were also concerned to avoid any remaining ambiguities concerning the character of filtered X-radiation, and so these two specimens and a few of our own have been examined with copper *K*α radiation obtained with a flat crystal monochromator of the type described by Lipson, Nelson and Riley[4]. With a 10-cm. diameter camera, hydrogen-filled during the photographic exposure, all specimens have given X-ray patterns showing none of the anomalous reflexions specified by Gibson in his note. One of these patterns is reproduced in the accompanying figure.

A specimen of graphite which we have recently had occasion to examine provides some additional evidence concerning the hexagonal and rhombohedral structures. The X-ray powder photograph contains the usual lines for both structures, but the reflexions for the rhombohedral form, characterized by the sequence *ABCABC* . . ., are of appreciably greater density than has been noted previously. It is estimated that as much as 25 per cent of the rhombohedral type of graphite occurs in this specimen, as against 10–15 per cent in most other specimens. The relevant part of the powder photograph is reproduced below. The significant feature of the X-ray examination is that, although so many lines for the rhombohedral structure appear of enhanced strength, no anomalous or forbidden reflexions can be detected. The result provides strong confirmation of the validity of the interpretation of the X-ray data given by Lipson and Stokes. There seems little reason for doubting that all features of X-ray powder photographs of graphite are explained by the co-existence of hexagonal and rhombohedral forms.

In conclusion, we would endorse the remarks made by Nelson and Riley in the accompanying letter. Filtered *K*-radiation certainly provides an effective 'monochromatic' beam for general purposes. Our experience is that it is reasonably satisfactory for the examination of graphites, provided the target material is carefully selected and the X-ray set is kept in good condition. But the limitations have to be recognized, and when structural details of the type in question have to be investigated, the final test must reside with a crystal-monochromatized beam.



PARTS OF X-RAY POWDER PHOTOGRAPHS OF NATURAL GRAPHITE
(*a*) Purified Ceylon graphite, ash content 0·07 per cent: with crystal monochromatized (copper *K*α) radiation, 10-cm. camera. (*b*) Purified natural graphite, origin unknown: with filtered (copper *K*) radiation, 19-cm. camera.

As Nelson and Riley point out, a reflexion of the intensity of the 0002 reflexion from graphite does, in fact, provide a good means of analysing the spectrum of the X-ray beam employed.

H. P. Rooksby
E. G. Steward

Research Laboratories,
General Electric Co., Ltd.,
Wembley.

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[1] Gibson, J., *Nature*, 158, 752 (1946).

[2] Lipson, H., and Stokes, A. R., *Proc. Roy. Soc.*, A, 181, 101 (1942).

[3] See also Nelson, J. B., and Riley, D. P., *Proc. Phys. Soc.*, 57, 477 (1945).

[4] Lipson, H., Nelson, J. B., and Riley, D. P., *J. Sci. Instr.*, 22, 184 (1945).

Phase-Contrast in the Photomicrography of Metals

The method of phase-contrast[1] has been successfully applied in this Laboratory to the 'vertical' illumination metallurgical microscope.

In the course of studies on the microstructure of alloy steels, heat-treated to show "intermediate transformation products"[2], photomicrographs of the ordinary type, such as Fig. 1, have been obtained from samples etched with nitric acid in alcohol. These show areas of two materials, the martensite representative of the transformed austenite and the "intermediate transformation product"; but owing to their similar light-reflecting properties, it is not always easy to distinguish them from one another, and the most prominent features are simply the black lines indicating their mutual boundaries.

Electron micrographs of the same specimen, such as Fig. 2, produced from negative ('Formvar') replicas[3], give higher resolution, but, in addition, show greatly improved contrast between the martensite and the "intermediate transformation product". The latter has been attacked more rapidly by the nitric acid, and its surface-level is therefore below that of the martensite; but whereas the electron microscope technique is very sensitive to this change in level, the normal light microscope does not appreciate it.

These characteristic differences in level should give rise to characteristic differences in phase in light reflected from the metal, and the phase-contrast method will convert such differences in phase into observable differences in light intensity. (A complicating factor is the possibility of differences in phase change on reflexion depending on the varying nature of the areas as distinct from their varying levels.)

A 'vertical' illumination microscope with specially designed phase-contrast modifications has been set up, and Fig. 3 is a phase-contrast photomicrograph obtained from it. There is a very clear distinction between the "intermediate transformation product" (dark areas) and the martensite (light areas), and the general correspondence between the tone values in this phase-contrast photomicrograph and those in the electron micrograph of Fig. 2 is noteworthy.

Fig. 1

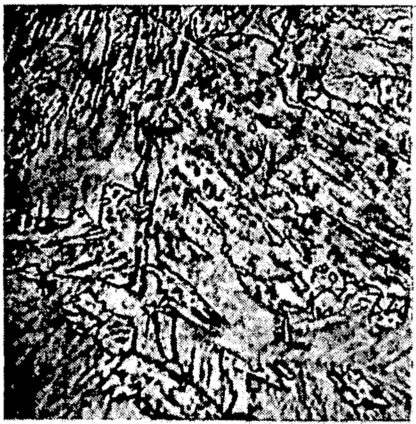
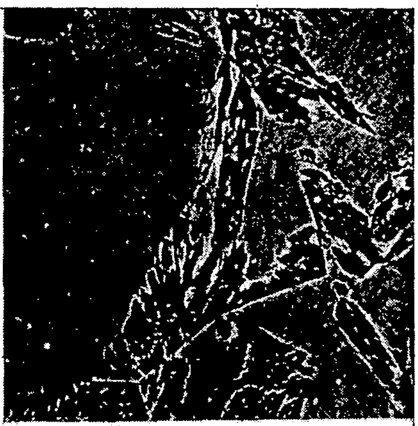


Fig. 2



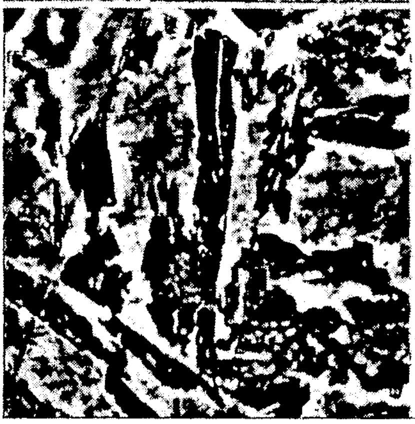


Fig. 3

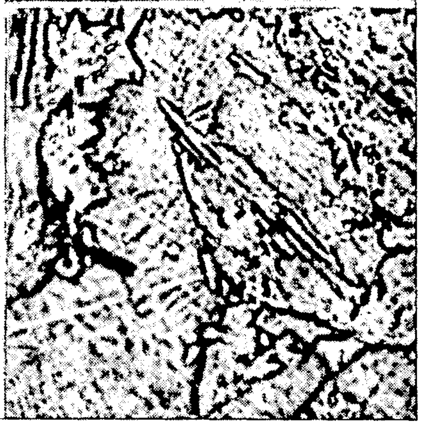


Fig. 4

Fig. 1. Normal photomicrograph
Fig. 2. Electron micrograph
Fig. 3. Phase-contrast photomicrograph
Fig. 4. Photomicrograph control for Fig. 3. × 1,600

Since contrast-levels can so easily be adjusted photographically by suitable choice of plates and printing papers, Fig. 4 is included as a 'control' on Fig. 3. It shows yet another area of the same specimen taken with the same objective lens (42-mm. oil immersion) and with the same photographic materials as the phase-contrast photomicrograph of Fig. 3, but *without* phase-contrast and at a somewhat reduced aperture.

Direct observation on the 'vertical' illumination phase-contrast microscope therefore provides valuable information previously only obtained indirectly through the agency of replicas and photographic means on the electron microscope. Such direct observation is a very valuable feature, and it is therefore felt that this development places in the hands of metallurgists and others interested in surface structures a new tool of considerable interest.

Further details will be published elsewhere.

The work described here has been carried out as part of the general research programme of the National Physical Laboratory, and this note is published by permission of the Director of the Laboratory.

The photomicrograph of Fig. 1 was prepared by Mr. J. L. Heslegrave and the electron micrograph of Fig. 2 by Mr. J. Trotter.

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March 3.

---

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Felting of Animal Fibres

WHEN a mass of loose wool or fur is rubbed in presence of an aqueous solution of acid or alkali, a felt is produced because the surface scale structure of the fibres causes them to migrate in the direction of their root ends. In the preparation of rabbit fur for felting, it is customary to treat the tip ends of the fibres, before the skin is cut away, with a solution of mercuric nitrate in nitric acid. The process, known as 'carroting', has the effect of enhancing the felting power of the fibres, and similar results can be obtained with other oxidizing agents, such as hydrogen peroxide, in presence of suitable catalysts. In all cases, the essential reaction is disulphide-bond breakdown, which was believed to be beneficial[1] because the tip ends of rabbit fibres are coarser than the roots. After treatment, the tips of the fibres are much less resistant to deformation, with the result that they are able to follow the finer root ends through entanglements which would otherwise have obstructed further movement and felting.

Although the process of 'carroting' is centuries old, its exact purpose has only recently been recognized[1], and no attempt has been made, therefore, to enhance the felting power of fur fibres by using reducing agents, instead of oxidizing agents, to cause disulphide-bond breakdown in the tips. It has now been found that treatment with a 10 per cent solution of sodium metabisulphite in aqueous alcohol[2] for one hour at 50° C. is particularly effective, even with wool fibres, which are uniform in diameter along their length.

Locks of 58's Australian cross-bred wool were treated with sodium metabisulphite over various fractions of their lengths, starting from the tip, 'carded', and then felted (4-gm. samples) for 30 minutes in presence of soap in a model felting machine[3]. The results are given in Table 1, where the degree of felting is indicated by the value of the 'compression resistance', which is the ratio of the thicknesses of the felted pad under standard high and low pressures. Maximum felting is obtained when half the length of the fibres, starting from the tip, is treated with sodium metabisulphite.

TABLE 1

Reagent	Fraction of lock treated	Compression resistance
Sodium metabisulphite	None	0·717
	Tip ¼	0·814
	Tip ½	0·826
	Tip ¾	0·720
	Whole lock	0·609

It is obvious that such a high degree of entanglement as exists in a finished felt could not be brought about unless the root ends of migrating fibres are sufficiently rigid to force a way through entanglements made in earlier stages of the felting process[4]. This is, no doubt, the reason why the degree of felting is least when the whole fibre is treated with sodium metabisulphite. As, however, the flexural rigidity of intact wool fibres is low, it seemed likely that improved felting might be obtained by hardening the root ends of fibres instead of softening the tips. This deduction was confirmed by treating locks of wool with a solution of mercuric acetate ($0{\cdot}1M$) in acetic acid ($0{\cdot}1N$) for one hour at 25° C. Mercuric acetate is by far the most effective cross-linking agent for animal fibres[5], and the results obtained with wools which were cross-linked over various fractions of their lengths, starting from the root end, are given in Table 2.

TABLE 2

Reagent	Fraction of lock treated	Compression resistance
Mercuric acetate	None	0·717
	Root ¼	0·761
	Root ½	0·694
	Root ¾	0·545
	Whole lock	0·387

The highest degree of felting is obtained when about a quarter of the length of the fibres, starting from the root end, is treated with mercuric acetate.

As would be expected, there is a dramatic rise in the felting power of animal fibres when hardening of the root ends is combined with softening of the tips, and this principle is likely to form the basis of the 'carroting' processes of the future. At present, the best practical means of carrying out such processes seems to be to harden the whole fibre with cross-linking agents and then to soften the tip by means of reagents which cause disulphide-bond breakdown.

We are indebted to the International Wool Secretariat for grants in aid of the investigation.

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March 8.

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[1] Speakman, *J. Text. Inst.*, **32**, T83 (1941).

[2] Speakman, B.P. 453,700.

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[4] Martin, *J. Soc. Dyers and Col.*, **60**, 325 (1944).

[5] Speakman and Coke, *Trans. Farad. Soc.*, **35**, 246 (1939). Barr and Speakman, *J. Soc. Dyers and Col.*, **60**, 335 (1944).

Total Emission Noise in Diodes

C. N. SMYTH[1] has shown that the space-charge between anode and cathode in the cut-off region of a diode gives rise to a large input conductance $1/R$ at ultra-high frequencies. He has also put forward arguments that the space-charge behaves as an additional source of noise at ultra-high frequencies. Hence it might be worth while to measure the 'equivalent noise temperature' T_e of the conductance $1/R$, T_e being defined by

$$\overline{i^2} = \frac{4k\,T_e\,\Delta\nu}{R}, \qquad (1)$$

in which $\overline{i^2}$ denotes the mean square noise current in a frequency interval $\Delta\nu$ and k is Boltzmann's constant.

Measurements were carried out at 7·25 m. wave-length on a diode having an emitting cathode area of about 10 cm.[2] and an anode-cathode distance of 0·1 cm., using a saturated diode as a standard noise generator. In this way we were able to measure the input damping $1/R$ as well as the equivalent saturated diode current I_e, defined by the relation :

$$\overline{i^2} = \frac{4k\,T_e\,\Delta\nu}{R} = 2e\,I_e\,\Delta\nu, \qquad (2)$$

where e is electronic charge.

The results are shown in Figs. 1 and 2. In Fig. 1 $1/R$ is plotted against V_a, in Fig. 2 I_e against V_a for a heater voltage $V_f = 12$ V., as well as for $V_f = 8$ V. It is shown in Fig. 2 that the equivalent noise current I_e is much larger than the anode current I_a.

Measurements of the characteristic showed that the saturation currents for $V_f = 12$ V. and for $V_f = 8$ V. differed by a factor 50. $1/R$ and I_e are only slightly dependent upon the saturation current I_s ; a change in I_s by a factor 50 corresponds to a change in $1/R$ and I_e by about a factor 3.

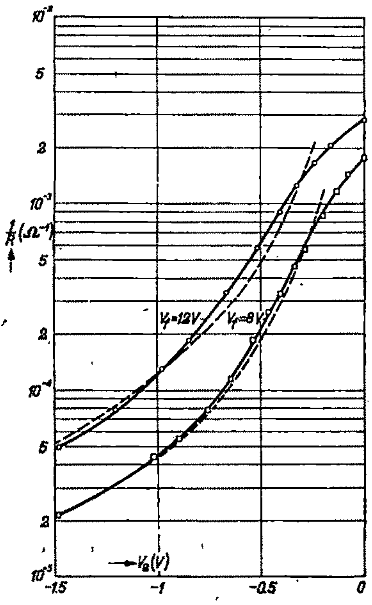

Fig. 1

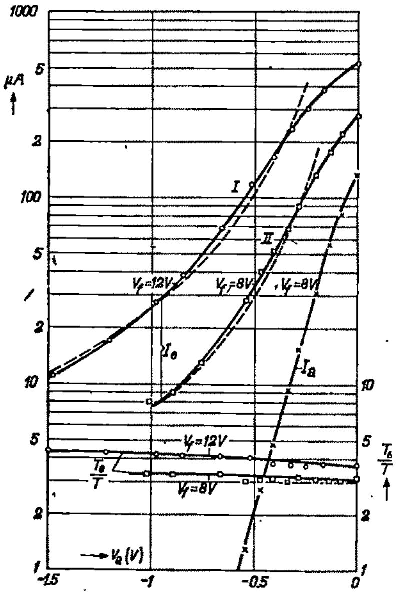

Fig. 2

Fig. 1. $1/R$ AS A FUNCTION OF V_a FOR HEATER VOLTAGES OF 12 V. AND 8 V.

Fig. 2. I_e, I_a AND T_e/T AS A FUNCTION OF V_a FOR HEATER VOLTAGES OF 12 V. AND 8 V.

$1/R$ and I_e are approximately proportional to V_a^{-2}. This follows directly from Figs. 1 and 2, in which dotted curves $C\,V_a^{-2}$ are drawn ; the values of the constant C are chosen such that each dotted curve coincides with the corresponding full-drawn curve at $V_a = -1{\cdot}0$ V. As T_e is proportional to $I_e R$, we should expect T_e to be approximately independent of V_a. This is shown in Fig. 2, in which T_e/T (T denoting normal room temperature = 290° K.) is plotted against V_a for $V_f = 12$ V. and for $V_f = 8$ V.. According to these curves, the average values of T_e at $V_f = 12$ V. and at $V_f = 8$ V. are approximately equal to 1,200° K. and 900° K. respectively; this nearly coincides with the actual cathode temperature.

Hence our final result is that the total emission noise may be described by assuming the 'equivalent noise temperature' T_e of the conductance $1/R$ to be equal to cathode temperature. It is to be expected from a theoretical point of view that this result will hold for a very wide frequency range, because $1/R$ and I_e are both proportional to the square of the frequency.

A fuller account of our investigations will be published elsewhere.

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[1] Smyth, C. N., *Nature*, 157, 841 (1946).

Polarization of Infra-Red Radiation

A METHOD of making thin selenium films with free surfaces has been devised, and this has enabled us to construct a pile of selenium films which polarize a beam of radiation falling on the plates at the appropriate angle. The transmitted beam is the one which is used, and a high degree of polarization (with very little loss of efficiency) is obtained with only three films. The films are not perfectly flat; since, however, they are only a few microns thick, this introduces no distortion in the transmitted beam, and is of service in eliminating the loss of polarization due to multiple reflexions. The films show a small absorption at a wave-length of 2 μ, but are otherwise transparent so far as we have examined them (about 7 μ).

Some interesting cases of pleochroism in sucrose have been reported by Ellis and Bath[1], who observed the absorption of radiation polarized by a Glan–Thompson calcite prism in the very near infra-red (up to 1·7 μ). This method restricts observation to the overtones of the molecular vibration bands which occur in this region. The selenium polarizer, however, can be used over a wide range of wave-lengths in the infra-red spectrum. We have made preliminary experiments to determine how the intensity of absorption depends on the orientation of the molecule with respect to the plane of vibration of the incident radiation. Marked effects have been found in the absorption spectrum of naphthalene (a crystalline material) and of nylon (an oriented film of a linear polymer). For example, in naphthalene, with the direction of propagation of the incident radiation perpendicular to the plane containing the *a* and *b* axes, and the electric vector parallel to the *b* axis, the absorption of bands at 3·3 μ, 2·1 μ, and 2·2 μ is considerably stronger than when the electric vector is parallel to the *a* axis. Other bands in this region are not affected. In the case of nylon, the absorptions between 3 μ and 3·2 μ corresponding to stretching the CH and NH bonds are more intense when the incident light vector is perpendicular to the direction of the stretched chains. This is in harmony with current ideas on the structure of nylon. We have also observed differences in the relative intensities of bands in the region 6 μ to 7 μ.

It is expected that the use of polarized infra-red radiation will be of service in identifying absorption frequencies with particular modes of vibration of the molecule, and in correlating the direction of valence links with the external surfaces of oriented materials.

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A Spherically Symmetrical Non-Static Electromagnetic Field

WE have recently found the most general non-static solution of spherical symmetry satisfying the relativistic equations of electromagnetism, namely,

$$G_{\mu\nu} - \tfrac{1}{2}GJ_{\mu\nu} = -8\pi T_{\mu}^{\nu}, \quad (1)$$

where

$$T_{\mu}^{\nu} = -F^{\nu\sigma}F_{\mu\sigma} + \tfrac{1}{4}\delta_{\mu}^{\nu}F^{\alpha\beta}F_{\alpha\beta}, \quad (2)$$

$$F_{\mu\nu} = k_{\mu,\nu} - k_{\nu,\mu}, \quad (3)$$

$$F^{\mu\nu}{}_{,\nu} = J^{\mu}, \quad (4)$$

in the usual notation[1]. The line element is

$$ds^2 = -(1 - 2m/r)^{-1}\,dr^2 - r^2\,(d\theta^2 + \sin^2\theta\,d\varphi^2) + \dot{m}^2\,(1 - 2m/r)/f^2.dt^2, \quad (5)$$

where

$$f \equiv f(m) = m'(1 - 2m/r), \dot{m} \equiv \partial m/\partial t, m' \equiv \partial m/\partial r. \quad (6)$$

The surviving components of the tensor T_{μ}^{ν} are four:

$$-T_1^{\,1} = T_4^{\,4} = m'/4\pi r^2,\ T_1^{\,4} = m'^2/4\pi\dot{m}r^2,\ T_4^{\,1} = -\dot{m}/4\pi r^2. \quad (7)$$

If we interpret T_{μ}^{ν} as

$$T_{\mu}^{\nu} = \rho v_{\mu}v^{\nu},\ v^{\mu}{}_{,\nu}v^{\nu} = 0, \quad (8)$$

and define

$$\frac{d}{d\tau} \equiv v^1\frac{\partial}{\partial r} + v^4\frac{\partial}{\partial t}, \quad (9)$$

$$v^1 = \sqrt{f(m)/4\pi\rho r^2}, v^2 = 0, v^3 = 0, v^4 = -m'v^1/\dot{m}, \quad (10)$$

$$dm/d\tau = 0, dv^1/d\tau = 0, d(4\pi r^2\rho)/d\tau = 0. \quad (11)$$

Both ρ and $f(m)$ are arbitrary. We note that m is conserved along a line of flow.

It is interesting to note that there are several solutions of (3) and (4) consistent with (5). One solution is given by

$$k_1 = -\frac{m'}{\sqrt{(4\pi f)}}\cos^{-1}(\sin\theta\sin\varphi),$$
$$k_2 = 0,\ k_3 = 0, \quad (12)$$
$$k_4 = -\frac{\dot{m}}{\sqrt{(4\pi f)}}\cos^{-1}(\sin\theta\sin\varphi).$$

$F_{\mu\nu}$ and J^{μ} can be readily calculated. Results corresponding to (10) and (11) follow for this interpretation of T_{μ}^{ν}. All such solutions and their details will be published elsewhere.

The line element (5) was first published by one of us[2] some years ago. A line element equivalent to (5) but not obviously so was obtained by Mineur[3] several years earlier. No attempt, however, seems to have been made to obtain the electromagnetic interpretation of the line element in terms of k_{μ} and J^{μ}.

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---

[1] Tolman, R. C., "Relativity, Thermodynamics and Cosmology", 259 (1934).

[2] Vaidya, P. C., *Curr. Sci.*, 12, 183 (1943).

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Existence of New Types of Wakes Behind a Moving Body

A QUESTION which to me seems very interesting was posed by Dr. Christopherson in *Nature* of March 8, p. 345: Can an approximate (numerical) computation establish either the existence or non-existence of a mathematical solution? He was describing a recent use of relaxation methods to find new types of wake behind a moving body, and expressed himself as satisfied that these exist. But the paper which recorded these computations also recorded failure to discover behind a 'planing surface' a motion of the fluid involving waves. This failure had not been expected, and Dr. Christopherson concludes (as I think, rightly) that it should be regarded as a null result from an ideal experiment.

For my own part, though I believe in the existence of finite wakes, I should do so with less confidence if the only evidence were the solutions which Miss Vaisey obtained on the basis of finite differences; for if the down-stream junction had been one of two streams impinging at a small angle, then (as was remarked to us by Sir Geoffrey Taylor) a small 'splash' would have been directed upstream from the junction, and this might have been so small as to escape detection (its thickness might have been smaller than our mesh-length). On that account, in the paper, an argument for the existence of finite wakes was based on the 'membrane analogue' of inviscid motion. I think that a case was made; but what I should consider a more convincing argument would be some *exact* solution for a finite wake—and I am hopeful of finding one.

As regards the motion behind a planing surface, while agreeing with the view expressed by Dr. Christopherson I should, perhaps, correct his statement that what appears to be non-existent is a motion in which the depth is the same far upstream and far downstream of the plane. What we have sought without success is a motion involving waves downstream but not upstream. I do not think it would have been difficult to find a solution involving stagnation on both sides of the plane, and the same depth far away from it; but this would have little importance, for it would also entail an infinite velocity at the trailing edge. It must be emphasized that our paper dealt with an *inviscid* fluid, in which results of this kind are acceptable mathematically, with other conclusions still less in accord with experience. All our solutions, for example, would *in theory* hold with the velocities reversed.

Our paper, being concerned with computation, did not seem to be the place for physical speculation; but for my own part I suspect that friction plays an essential part in the production of waves behind a barrier or trailing surface. Perhaps some day we shall be able to test this conjecture by computations which take account of viscosity. I should be hopeful if I were sure that the wave motions are 'stream-line', but I suspect that the time-variable enters, and I see little prospect of handling three independent variables—at least, until machines become available.

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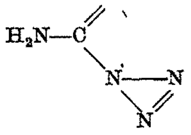
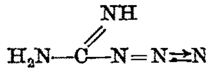
Coupling of Diazonium Complexes from an Aliphatic Base

THE formation of diazonium complexes from unsaturated amines is not a unique property of the aromatic series. Many, but not all, unsaturated heterocyclic amines respond similarly[1]. With aliphatic amino-compounds, nitrous acid, under certain conditions, may give a diazo-grouping but not an ionizable diazo-derivative. In the literature it would appear that aminoguanidine is the only straight-chain compound so far recorded as being in line with the aromatic amines. Even in this example the tendency is to form an intermediate heterocyclic compound, and it is only under special conditions that a straight-chain diazonium derivative is obtained.

During some work on the action under different conditions of sodium nitrite on aminoguanidine, (*a*) a relationship has been found between the products formed, and (*b*) the nature of the resulting coupled-bodies also has been determined.

Thiele[2] treated aminoguanidine with sodium nitrite in the presence of free mineral acid and isolated a derivative which Hantzsch and Vagt[3] considered to be guanyl azide, with the structure shown in (I), but which in the light of modern resonance theory would probably be that in (II):

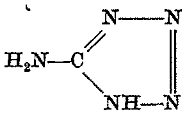

(I)



$$\mathrm{H_2N{-}\overset{\displaystyle NH}{\overset{\|}{C}}{-}N{=}N\rightleftarrows N}$$

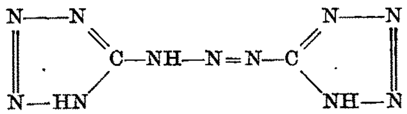
(II)

This azide, when treated with weak bases, isomerized to 5-amino-tetrazole:



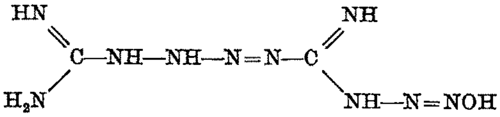
which when disazotized in the usual way gave a diazonium salt (*A*), which coupled with such intermediates as α- and β-naphthol to give azo compounds.

Hofmann and Hock[4] treated aminoguanidine with sodium nitrite in the presence of glacial acetic acid and isolated 1-3-ditetrazolyltriazene (*B*):



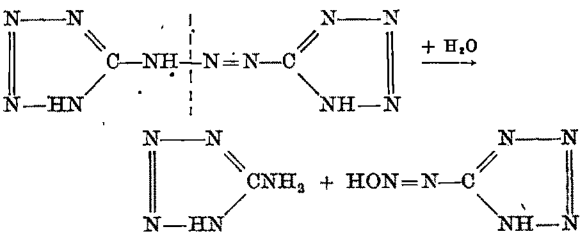
which when heated with a weakly alkaline solution of β-naphthol gave an orange-coloured solution.

The same workers[5] isolated 1-guanyl-4-nitrosoaminoguanylisotetrazene (*C*):

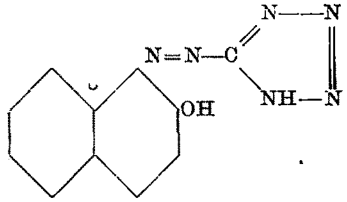


by the action of sodium nitrite on aminoguanidine in neutral solution. This also, under similar conditions, gave an orange-coloured solution with β-naphthol. This coloured compound was isolated from solution by Norris-Shreve, Carter and Willis[6], who showed that it possessed the properties of an azo dye.

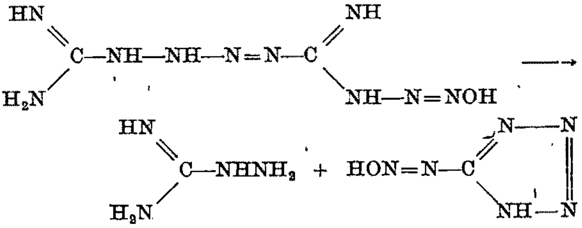
During the course of the present work, it was shown that the coloured compounds obtained with β-naphthol from each of the above three 'diazo' derivatives were identical in all respects. Their formation, however, proceeds differently. In *A*, the coupling takes place at ordinary temperatures with no evolution of nitrogen. In *B* and *C* the reaction is carried out at 80° C. In the case of *B*, splitting appears to occur at the $-\mathrm{NH}\vdots\mathrm{N}{=}\mathrm{N}-$ link, forming 5-amino tetrazole and diazotetrazole (diazonium hydroxide).



This diazotetrazole now couples with the β-naphthol in the α-position forming 1-2-3-4-tetrazole 5-azo-β-naphthol.



The case of coupling with 1-guanyl-4-nitrosoaminoguanylisotetrazene (*C*) is more complicated. Splitting takes place as in the case of *B* at the $-\mathrm{NH}\vdots\mathrm{N}{=}\mathrm{N}-$ link as indicated:



with the formation of aminoguanidine on one hand and diazotetrazole on the other, through ring closure as shown. The diazotetrazole couples, as in the case of *B*, if an intermediate is present. In the absence of a coupling intermediate, such as β-naphthol, the diazotetrazole loses two atoms of nitrogen, forming hydroxytetrazole.

To substantiate the structure of the foregoing β-naphthol complex, a series of reduction experiments were carried out on this substance. In all cases the products were found to be α-amino, β-naphthol and 5-aminotetrazole.

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March 3.

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[2] Thiele, *Ann.*, **270**, 46 (1892).

[3] Hantzsch and Vagt, *Ann.*, **339**, 314 (1900).

[4] Hofmann and Hock, *Ber.*, **43**, 1866 (1910).

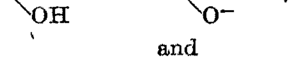
[5] Hofmann and Hock, *Ber.*, **43**, 682 (1910).

[6] Norris-Shreve, Carter and Willis, *Ind. Eng. Chem.*, **36**, 472 (1936).

Relationships Between some Dissociation Constants

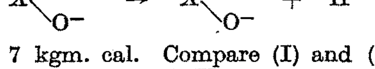
IN these Laboratories the fungistatic properties of ethylenic and acetylenic compounds have been studied recently[1]. Our results indicated that biological activity was connected with the presence of substituents that attract electrons strongly, and led us to a consideration of the dissociation constants of compounds which donate protons (that is, acids as defined in the broadest sense), since these constants form a basis for a comparison of the affinity for electrons of radicals and groups. During the course of this work, relationships were found between certain dissociation constants, which constants are conveniently expressed as ΔF $(= -RT.\log_e K)$[2] for the reaction $RH \rightarrow R^- + H^+$ taking place in dilute aqueous solution at 25° C. Although the relationships summarized below are of general application, space here does not permit them to be illustrated by long lists of examples, and so, as far as possible, only the values of ΔF (calories) for the seven acids, H_3PO_4 (I) + 2,900; $H_2PO_4^-$ (II) + 9,800; HPO_4^{--} (III) + 16,900; H_2SO_3 (IV) + 2,400[3]; HSO_3^- (V) + 9,800[3]; HSO_4^- (VI) + 2,300 and HOCl (VII) + 10,100[4,5], have been used in this discussion

(1) The values of ΔF for the two reactions



$$X\langle{}^{OH}_{OH} \rightarrow X\langle{}^{OH}_{O^-} + H^+$$

and



$$X\langle{}^{OH}_{O^-} \rightarrow X\langle{}^{O^-}_{O^-} + H^+$$

differ by 7 kgm. cal. Compare (I) and (II); (II) and (III); and (IV) and (V).

(2) The addition of a doubly bonded oxygen atom to the atom attached to a dissociating hydroxyl group decreases the value of ΔF by 7 kgm. cal.; for example, (V) and (VI). One of the two effects (1) and (2) in reverse should cancel out the other, and indeed (IV) and (VI) do agree within the limits of the experimental error.

(3) In the reaction $-Y-H \rightarrow -Y^- + H^+$, the combination of an additional proton with Y or the replacement of an atom directly attached to Y by another higher in atomic number by one unit decreases ΔF by 14 kgm. cal.; compare (III) and (VI). The difference, 14 kgm. cal., is so large that accurate measurement of both dissociation constants is usually difficult. However, the effect (3) can be reduced by combining it with (1) or (2), and the difficulty then disappears. The dissociation constant of a hydroxylic acid should, in fact, be unaltered if the atom attached to the hydroxyl group is moved back one place in the periodic table (ΔF changed by -14 kgm. cal.), and either: (*a*) two oxygen atoms are linked to the replacing atom by semi-polar double bonds $(+2\times 7)$ as in (V) and (VII); or (*b*) one oxygen atom $(+7)$ is attached and an extra proton is put on this oxygen atom $(+7)$ (examples are the pairs (I) and (IV) and (II) and (V)); or (*c*) two protons are added to oxygen atoms already attached to the replacing atom $(+2\times 7)$; (I) and (VI).

(4) In the reaction $-Y-H \rightarrow -Y^- + H^+$, the replacement of Y by an atom one higher in atomic number apparently decreases ΔF by 21 kgm. cal., at any rate when Y is carbon or nitrogen. This difference between the ΔF values is so large that it cannot be measured directly. However, ΔF for $AOH \rightarrow AO^- + H^+$ is greater than ΔF for $ANH_3^+ \rightarrow ANH_2 + H^+$. A comparison can be made with more than twenty different groupings for A, and the difference in the ΔF values is always close to 7 kgm. cal. This figure may be regarded as the net result of an increase in ΔF of 2×14 kgm. cal. due to the removal of two protons (effect 3) and a decrease of 21 kgm. cal. for the replacement of nitrogen by oxygen. This fourth effect is interesting because it suggests a means by which ΔF for carbon–hydrogen links can be estimated. For the dissociation of nitric acid, ΔF seems to be roughly $-1,000$ cal.[6]. From this by calculation for effects (3) and (4), ΔF for nitromethane should be $+13,000$ cal. The estimation of ΔF for nitromethane from that of nitramide $(+9,000$ cal.) leads to a figure of $+16,000$ cal. The experimental value of ΔF is $+15,000$ cal. The effect on the dissociation constants of pyridinium ions produced by substituents can now be used to throw light on problems of substitution in benzene derivatives.

This and other matters arising out of the discovery of these relationships will be discussed when a fuller account of this work is prepared for publication elsewhere.

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Nature of the Tryptophanase Complex

IN a previous communication[1] we described th preparation of a cell-free extract of tryptophanas from *Esch. coli* and its resolution into a coenzym fraction and an apoenzyme.

The effect of various inhibitors was studied, a summarized below, and afforded information as t possible components of the enzyme complex.

Mepacrine. The inhibitory effect of mepacrine on the growth an tryptophanase activity of *Esch. coli* has already been announced[2] b Dawson, and this inhibition is antagonized by riboflavin.

Cyanide. *M*/50 potassium cyanide produces complete inhibition for 2 hr. and 93 per cent inhibition up to 18 hr.

Sodium Azide. A concentration of *M*/100 produces 50 per cent inhibition at 30 min.

Benzamide. *M*/1,000 produces 50 per cent inhibition, and this can be nullified by the addition of nicotinic acid.

Carbonyl Inhibitors. Hydrazine and hydroxylamine both give complete inhibition over the period of an hour, down to concentration *M*/1,000. Semicarbazide inhibits to 64 per cent at 30 min. with concentration *M*/100.

Dimedon is without effect on tryptophanase activity[3].

Carbon Monoxide. Produces 25 per cent inhibition at 30 min.

Hydrogen Sulphide. Produces 28 per cent inhibition at 30 min.

Sulphanilamide. (*a*) In culture. Complete bacteriostasis and hence non-production of tryptophanase at concentration *M*/43 (4 mgm./ml.). Using tenth dilutions, there was complete bacteriostasis at 24 hr. down to concentration *M*/4300 (that is, 40 μgm./ml.). (*b*) Viable washed cells. Sulphanilamide has no effect on preformed tryptophanase.

British Anti-Lewisite (*B.A.L.*), 2 : 3 dimercaptopropanol. At concentrations of *M*/10 and *M*/20 gives complete inhibition for 60 min., this effect decreasing with concentration until it is not manifest at all at *M*/1,000.

Effect of Verdoperoxidase. A preparation of verdoperoxidase from leucocytes was obtained by the method of Kjell Agner[4]. Although not a very active specimen, pronounced stimulation of tryptophanase activity was recorded. Catalase and polyphenoloxidase have both been found to be absent from our extract.

The dialysate from cell-free tryptophanase has been examined spectrophotometrically, and the type of absorption curve obtained corresponded most closely to that of pyridoxal phosphate. Spectrochemical investigation of an unpurified sample of apoenzyme revealed the presence of iron, but not of copper. A microbiological assay of both dialysate and apoenzyme has also been performed, using *Lactobacillus casei E*, and riboflavin has been shown to be present in both.

Reconstitution of Tryptophanase. Using inactive apoenzyme, the various possible coenzyme factors were added in turn and the effect noted. In this way we have been able to show that pyridoxal phosphate, riboflavin and diphosphopyridine nucleotide are each capable of reactivating the apoenzyme; stronger activation is obtained with pyridoxal phosphate plus diphosphopyridine nucleotide and with riboflavin plus the nucleotide, whereas maximum effect is obtained by the addition of all three.

Discussion. The study of the effect of various inhibitors on the activity of tryptophanase initially provided strong presumptive evidence for the nature of the enzyme complex. The mepacrine inhibition and its antagonism by riboflavin gave indication of the functioning of flavoprotein in the complex, this being substantiated by the subsequent identification of riboflavin as a coenzyme factor. The effect of cyanide, hydrogen sulphide and carbon monoxide suggests that a cytochrome-type of system is operating, though it is known from the work of Keilin and Harpley[5] that cytochrome *c* and cytochrome oxidase are absent from *coli*, and also that bands *b* and *c* of normal cytochrome are replaced by one band which lies at 560 mμ and which represents the α-band of non-autoxidizable hæmochromogen component b_1.

A component containing the aldehyde or carbonyl grouping seemed likely from the way in which characteristic carbonyl reagents inhibited tryptophanase activity, and this has been reconciled with the presence of pyridoxal phosphate. In a similar manner the inhibition produced by benzamide, and antagonized by nicotinic acid, could be related to interference with a pyridino component such as diphosphopyridine nucleotide.

The effect of verdoperoxidase is of considerable interest. It has been suggested by Keilin[6] and Kuhn[7] that verdoperoxidase might be considered as more or less modified cytochrome-*a* derivatives. In view of absence of the cytochrome-*c* – cytochrome oxidase system, the marked increase in production of indole from tryptophane by our cell-free enzyme system in the presence of verdoperoxidase is of significance. Since *B.A.L.* is an inhibitor of metal-containing enzymes, as shown by Webb and Van Heyningen[8], this is compatible with the presence of an iron-containing system such as verdoperoxidase.

We should like to express our gratitude to Dr. E. F. Gale for a gift of pyridoxal phosphate, to Prof. R. A. Peters for *B.A.L.*, and to the Medical Research Council for a grant-in-aid.

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A Copepod Parasite of the Mussel New to the British Fauna

Mytilicola intestinalis is a worm-like copepod first found in 1902 by Steuer[1] in the intestine of the mussel *Mytilus galloprovincialis* from the Gulf of Trieste; since then, there have been a number of other records both from this mussel and *M. edulis*[2]. All these were from the Mediterranean area; but in 1939, Caspers[3] found it in mussels from the Bremerhaven–Cuxhaven area of the German North Sea coast, and, in February 1946, I found that mussels from the mouth of the River Blyth, Northumberland, were parasitized. More than 90 per cent of the Blyth mussels examined were found to be infected; in one case, 18 specimens were obtained from a single host.

All the records seem to have been obtained from estuarine zones: Caspers found, in his area, that while mussels from the estuaries were heavily infected, those from neighbouring purely marine zones were completely free: in the present case, mussels from Holy Island, the only purely marine bed on the Northumberland coast, were found to be uninfected. I hope to examine mussels from other estuaries in this area in due course.

Where the parasite was present, Caspers found that most mussels were infected, often heavily—he found 14 specimens in a single host. Finding it hard to believe that such a heavy infestation could have occurred in a short space of time, he considers that previously the parasite must have been overlooked. It is difficult to believe that the parasite could have been overlooked in the present case. Mussels from the Blyth have long been used in this Department as experimental material, often as a source of crystalline styles; as the parasite is quite large, adults being more than 1 cm. long, and fairly obvious because of their hæmoglobin, the search for the styles should have revealed their presence. But it would be very interesting to know whether, in fact, the parasite is a recent arrival to Great Britain; knowledge of its presence and, equally important, its absence, from estuarine mussels of other parts of the country would be invaluable, and I would be very grateful for information on this point.

The parasite should be very useful for teaching and other purposes, for the ease with which living *Mytilus* can be sent through the post means that, probably for the first time, a living parasitic copepod will be easily available to inland laboratories; mussels from the Blyth may be obtained from the Dove Marine Laboratory, Cullercoats, Northumberland.

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March 11.

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Copper in Diatoms

Work undertaken in this Laboratory suggests that certain species of diatoms, which are the normal constituents of the slime film which forms upon a submerged surface in marine waters, contain copper, far in excess of the amount usually considered lethal for unicellular Algæ. (Half to one part per million is usually sufficient to remove algal growths from reservoirs.) Large colonies of marine diatoms were gathered freshly during the spring maximum of 1946, from a raft located in Chichester Harbour. Sixteen samples were examined: Nos. 1–12 inclusive were species which live in frondose colonies of mucous filaments, 5–10 cm. in length; samples Nos. 13–16 inclusive were species which grow either upon mucous stalks or embedded within a flat film.

After collection, the material was examined carefully and sorted into monotypic samples, care being taken to remove any contaminants such as filamentous seaweeds. The selected material was washed several times with filtered sea water, and examined for copper, using sodium diethyldithiocarbamate as an indicator. All samples gave a positive reaction, while samples 3–11 were submitted further to a quantitative estimation. The quantitative determination of copper was effected by the use of the absorptiometer method described by Haywood and Wood[1], with some special modifications. The selected material was washed free from salt and dried in a vacuum desiccator for 48 hours. Weighed portions of 0·5 gm. were wet-ashed; ammonium citrate was added in order to inhibit any iron that might be present, and strong solution of ammonia added, sufficient to produce an alkaline reaction. The mixture was then filtered to remove the siliceous skeletons of the diatoms, and the volume adjusted. Sodium diethyldithiocarbamate was added to a measured quantity of the mixture, which was allowed to stand for 15 minutes. The copper complex developed a yellow coloration, which was extracted by shaking with carbon tetrachloride, and estimated on a Hilger 'Spekker' absorptiometer.

The results showed that the diatoms contained from 31 to 164 parts per million of copper (weight/weight). The copper content of the sea water in which the diatoms lived was 0·007 mgm. per litre (7 parts per thousand million). It is not known in which form the copper is contained, but it is likely that it forms either an additive compound with the protein or alginin molecule within the diatom cell, and is thrown down as a coagulate or precipitate, or that it plays a functional part in the chromatophores.

Evidence from work upon cultures of diatoms without their siliceous frustules[2] indicates that the organisms can tolerate copper far in excess of that allowed by the range of solubility of copper in sea water of pH 7·92–8·2, which probably does not exceed 0·5 parts per million. It appears that the diatom forming so large a part of the slime which develops upon an underwater surface may be considered as a potential reservoir of copper, and in this way may play an important part in preventing the settlement of other and more sensitive fouling organisms.

Acknowledgment is made to the Board of Admiralty for permission to publish the foregoing work, which forms part of a general investigation in progress in this Laboratory on the anti-fouling problem relating to ships.

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The New Lava from Hekla

On April 10 I received from Dr. Jóhannes Áskelsson of Reykjavik a specimen of the new lava from Hekla. Dr. Áskelsson states that the eruption began on March 29 at 7 a.m. (Icelandic time), and several lava streams began to flow in different directions. The specimen he sent was taken from the surface of the moving lava of a stream flowing east from the northern end of the Hekla ridge. It is a typical *aa* or block lava.

The rock is a dead black, highly slaggy basalt in which a few fresh white feldspars are entangled. In thin section the bulk of the rock turns out to be a brownish-black glass holding numerous swallow-tailed feldspar microlites, a few micro-phenocrysts of labradorite (Ab_1An_1), and still fewer of pyroxene and olivine.

This lava is identical with previous flows from Hekla, as I have ascertained by direct comparison with material collected by Sir George Steuart Mackenzie in 1810[1], which is preserved in the Hunterian Museum of the University of Glasgow. It is also identical with the Selsundhraun (*hraun*, Icel.=lava), a Recent flow 10 km. south-west of Hekla, of which I possess an unpublished analysis. This analysis agrees very closely with H. S. Washington's analysis of a Hekla lava from Nafrholt[2], and with Recent lavas from the Vatnajökull region[3]. All these magmas are slightly over-saturated with silica notwithstanding the early crystallization of a little olivine. It may therefore be concluded that the Recent basalt lavas of Iceland are very uniform in composition, and that there has been little or no change in that respect during the historical period.

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April 22.

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RADIO AIDS TO MARINE NAVIGATION

ONE of the earliest applications of radio wave transmission was the introduction of a service whereby ships could be informed of their position under conditions in which ordinary visual observations or dead reckoning were not very reliable. For many years past, radio direction-finding stations on shore have supplied bearings to ships making special signals for the purpose; while many forms of direction-finder suitable for installation in ships have also been available, and could be used for observing the bearings of fixed radio beacons, which can easily be identified by the simple code signals emitted at regular intervals. During the past seven years, the growth and development of radio technique has been so rapid and so extensive that not only has a great deal of advance been made in the field of radio direction-finding as such, but also there has been devised and developed a number of alternative systems of using radio waves for fixing the position of a ship, whether it be in the open sea, near a coast or approaching a harbour. There are, in fact, so many possible systems of radio aids to marine navigation that it has become quite a difficult problem to decide which are the best or most appropriate for various applications. In order to reduce the number and variety of equipments to be carried by ships navigating in various parts of the world, it is clearly desirable that there should be some measure of international agreement on the matter.

It was with the view of providing scope for a full discussion of the value of these radio navigational aids, and of discovering to what extent they meet the requirements of the navigator and shipowner, that the Ministry of Transport organised an international meeting in London in May 1946 (see *Nature*, **157**, 689; 1946). The meeting was attended by some 120 delegates from twenty-three different countries, and a complete record of the proceedings of the meeting with its many lectures, demonstrations and visits has recently been compiled in two volumes by the Ministry of Transport and published by H.M. Stationery Office*.

The first volume provides a record of the proceedings of the conference with a full report of the discussions that followed the introductory lectures on the various systems, these lectures being given chiefly by the British naval officers and Government scientific workers who had been closely associated with the developments described.

The second volume contains the full text of the scientific and technical documents presented at the meeting, and comprises, in effect, a very full and up-to-date handbook dealing with the whole problem of marine navigation by means of radio transmission and reception. After introductory chapters on the needs of the mariner for navigational aids, and on radio wave propagation as it affects them, the volume goes on to examine in detail all the radio navigational aids in existence or under development. One section deals with all aspects of radio direction finding, both from ship and from shore, and including the different types of radio beacon. Another section covers hyperbolic systems of navigation, including Loran, Gee, Decca and other names familiar to many in the Services during the War. A large section is devoted to marine radar in all its forms, as a ship-borne instrument, as a shore installation for harbour supervision and in the form of radar beacons. This section also includes a specification for a ship-borne radar set, drawn up by combining a knowledge of the user's needs with a knowledge of the technical possibilities. This should prove of great value to the radar manufacturer and the shipowner, because both will know that a set conforming to this specification will be in every way satisfactory.

The development of transmitting compasses for association with radio navigational aids is dealt with, as is also the question of the provision of special charts in order to facilitate the work of the navigator in using the various aids. In the later portions of the volume an appreciation, with considerable technical detail, is given of the various devices discussed, and an important chapter speculates on the probable future trends of development.

This whole volume, which is well illustrated with diagrams and photographs, is essentially technical, and it contains a large amount of information unobtainable anywhere else. It will present many with their first picture of the far-reaching developments in radio navigational aids as a result of the War, and of the application of these developments to the safer and more efficient operation of ships at sea. It should prove of wide interest, and invaluable as a text-book to all who are in any way concerned with radio aids to navigation.

The publication of these two volumes is very opportune, and was in good time to pave the way for the continuation of the discussions at the recent international meeting in the United States of America.

ROLE OF STARCH IN LIGHT-INDUCED STOMATAL MOVEMENT, AND A NEW REAGENT FOR STAINING STOMATAL STARCH

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THE mechanism of the movement of stomatal guard cells in response to the stimulus of light, although under investigation for nearly a century, is still in doubt. The classical view[1] that such movements are due to changes of turgor has received support from many workers, who have found by plasmolytic methods that with stomatal opening the osmotic pressure in the guard cells increases[2-6]. More recently, the possible collaboration of a 'wall mechanism' in opening the stomata of *Cyclamen* and *Tradescantia* has been disproved[7], so that a turgor mechanism alone must be concerned; but how the changes in turgor are produced is still uncertain. Mainly owing to the work of Lloyd[8], Hagen[9], Loftfield[10] and Sayre[5] it is very generally accepted that they are due to hydrolysis or condensation of starch in the guard cells, probably brought about by enzyme action governed by pH changes in response to light. A careful examination of these and other relevant papers, however, shows that nearly all the evidence for such a mechanism is based on the observation of diurnal changes in starch content and stomatal aperture under natural conditions. These observations leave little doubt that, under such conditions, pore size and starch content are to a large extent, though by no means completely, negatively correlated. A similar inverse relation is shown where change of aperture is experimentally induced by altering the water relations of the leaf[2], or by immersing detached pieces of leaf or epidermis in various solutions[11–14]; but such data are not necessarily relevant to the problem of a light response. Where stomatal movement has been experimentally induced by changes of lighting conditions, at other than the natural times, the evidence for a correlation between starch content and stomatal aperture is not convincing[8,15]. The correlation of diurnal trends is an unsafe basis for a causal theory, especially in this case, since it has been shown that in cherry laurel[16] and *Pelargonium*[17,18] there is a diurnal rhythm of stomatal movement even under conditions of constant illumination. The diurnal rhythm of stomatal starch, which has not been shown to be due to light, may well provide the motive power for such autonomous stomatal movements.

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* International Meeting on Radio Aids to Marine Navigation, May 1946. Vol. 1. Record of the Meeting and Demonstrations. 2*s*. 6*d*. net. Vol. 2. Radio Navigation: Radar and Position Fixing Systems for Use in Marine Navigation. 5*s*. net. (London: H.M. Stationery Office, 1946.)

Much of the uncertainty as to the relation between stomatal aperture and starch content arises from difficulties of estimation. Both stomatal apertures and guard cell starch show great variation between leaves and even on the same part of a single leaf. The measurement (usually by Lloyd's[8] method) of a sufficient number of stomata to give a satisfactory mean is tedious and seldom attempted, and errors in sampling procedure are probably common; for starch content no quantitative measure has been devised or seems possible, and subjective errors must be considerable. Furthermore, previous investigators have laboured under the great disadvantage of being unable to observe both aperture and starch simultaneously in the same stomata, because the aqueous iodine–potassium-iodide reagent used to stain the starch causes stomatal closure. This source of inaccuracy has now been overcome, for I have found that the reagent described below stains the starch very satisfactorily and causes no stomatal closure even in strips of epidermis that have been in absolute alcohol for a few days only. It has a very high refractive index, and excellent images may be obtained, either for visual work or photomicrography, by mounting the material in the reagent. The reagent is made by dissolving 2·5 gm. of iodine in 100 c.c. of phenol, containing the minimum amount of water necessary to make it liquid at room temperature and an excess of potassium iodide. The water-in-phenol solution may be conveniently obtained by leaving the stopper out of a bottle of pure phenol. The use of this reagent has made it possible to reduce subjective errors since photomicrographs showing both aperture and starch content may be compared. Photomicrographs of *Pelargonium* stomata have been taken which show approximately the same average starch content with relatively wide and relatively narrow apertures, in epidermal strips taken at the same time of day under conditions of light and darkness respectively. Here the possibility of diurnal rhythms in starch and aperture being concerned is eliminated. Photomicrographs from other experiments give evidence of increases in starch content without appreciable change of aperture, and even of decreased starch with decreased aperture.

Although the comparison of such photomicrographs reduces subjective errors and their publication will enable other workers to judge for themselves, the difficulties of taking representative samples and estimating mean values remain. If stomatal movement can be induced by light in the complete absence of starch, the matter rests on a more secure basis. I have been unable to find any starch (or chloroplasts) in the guard cells of onion stomata (*Allium cepa*, L.) either open or closed, thus confirming the observations of Parkin[19]. The investigations of Loftfield[10] using Lloyd's[8] method, showed that under natura conditions the stomata of the onion were motile but again an autonomous diurnal rhythm might have been concerned or a response to some external factor other than light. It has now been shown by porometer experiments that onion stomata respond in the normal way to light, and therefore this species at least has a light response which does not depend upon a starch $\rightleftharpoons$ sugar mechanism.

In view of the very diverse character of the numerous stimuli to which stomata respond it seems improbable that a unique mechanism is concerned, except to the extent that all responses must be due to turgor changes, and each type of stimulus will require separate investigation. For the present, only the response to light is under consideration, and here the evidence for a starch $\rightleftharpoons$ sugar mechanism seems inadequate.

This work will be published in detail elsewhere.

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THE INVERNESS-SHIRE EARTHQUAKE OF DECEMBER 25, 1946

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AT about 17 hr. 2 min. (G.M.T.) on Christmas Day, 1946, an earthquake of maximum intensity VI (C. Davidson scale), accompanied by sounds, originated close to Spean Bridge in Inverness-shire, and was felt throughout much of central Scotland. Associated with it were at least two fore-shocks and one after-shock.

Postal reports received in response to appeals through newspapers, questionnaire-cards and radio broadcasts show that the disturbed area included the eight shires of Ross, Inverness, Perth, Argyll, Edinburgh, Clackmannan, Stirling and Renfrew. The region enclosed by a first approximation to isoseismal IV (C. Davison scale) is about 3,500 square miles. Extreme points from which such reports have been received, to date, are Muir of Ord in the north, Glasgow in the south, Edinburgh in the east and Tobermory, Isle of Mull, in the west.

The fore-shock of December 24, 1946, associated with the main quake, was felt not only in Inverness-shire and Argyll, but also as far south as Fenwick, Ayrshire.

The epicentre of this earthquake lies in the Inverness–Oban seismic zone, which includes the fracture-system of the Great Glen fault. Interest attaches to the fact that the recent tremors indicate stress-relief in a part of this zone where only one other earthquake of the same order of intensity has been recorded hitherto[1]. This latter was noticed at Gairlochy, Spean Bridge and Roy Bridge, over a period of six seconds, between 22 hr. and 23 hr. (G.M.T.) on August 22, 1924, when it attained a maximum intensity of IV (C. Davison scale).

Regarding the most recent activities at foci in the same zone, adjacent to Spean Bridge, records indicate that tremors originated near Inverness in September[2] and October 1901[3] and near Oban in both December 1925 and May 1941. Thus, between 1901 and 1947 foci have been active in the sequence: Inverness, Spean Bridge, Oban, Oban, Spean Bridge, suggesting a return of stress-relief to the central region of the zone after previous manifestations of this relief in the north, centre and south of the zone, respectively.

Times and durations noted in the epicentral region lead to the conclusion that the quake of December 25, 1946, began about 17 hr. 2 min. (G.M.T.) as a rumbling sound of low pitch which continued for about two seconds. This was followed by three sharp tremors, occurring over a period of about three seconds, the first of which exceeded the intensity of either of the others. The last tremor was followed by a further rumbling sound which became inaudible after about three seconds.

Close to the epicentre, effects of the three main tremors were compared to those of sudden explosions, such as the detonations of hand grenades. In a surrounding zone only one tremor was noticed, generally preceded, but not always followed, by a sound. Beyond this zone a weak tremor was felt, usually unaccompanied by any sound.

Some observers described sounds heard about the epicentre as being similar to the deep rumbling of a heavy vehicle passing over a bridge, or thunder, or gunfire at a distance. Others compared them to the oaring of wind, or to the noise of a train in a tunnel. At places remote from the epicentre, the sound was said to possess a harsh, rasping quality.

The intensity of this earthquake appears to have exceeded that of August 22, 1924, in the same locality (namely, IV (C. Davison scale)), for on this recent occasion not only were the chairs of several seated observers noticeably moved at Gairlochy and Spean Bridge, but also a plaster ceiling was thrown down in Achnacarry at the east end of Loch Arkaig; a chimney-pot dislodged from a house at the north-east end of Loch Laggan; two heavy shop-safes moved in Fort William, and windows, doors and rockery rattled at many places in the area. These, nd similar phenomena, are consistent with a maximum intensity of about VI (C. Davison scale). Further, the position and form of the central disturbed area, and distribution of intensities within it, uggest a close association of this earthquake with the Great Glen fault-system. On the other hand, resent information suggests there was no significant sympathetic movement in the Highland Boundary fault-system at or about the time when these recent Spean Bridge disturbances took place.

A weak fore-shock connected with this earthquake appears to have occurred at about 17 hr. 20 min. (G.M.T.) on November 19, 1946, and a second one close to 24 hr. (G.M.T.) on December 23, 1946. The latter, which was noticed in Inverness-shire, Argyll and north Ayrshire, consisted of two tremors lasting about four seconds and three seconds respectively, separated by an interval of about two seconds.

The after-shock of January 5, 1947, would seem to have taken place at about 09 hr. 35 min. (G.M.T.), when a slight rumble was heard in West Glen Roy and Glen Spean, having a duration of about three seconds.

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[1] *Nature*, 114, 653 (1924).

[2] Davison, C., *Nature*, 64, 527 and 601 (1901).

[3] Davison, C., "A History of British Earthquakes", 30, 43-56 (1924).

INDUSTRY AND RESEARCH

CONFERENCE AT BIRMINGHAM

THE first of the regional conferences on "Industry and Research" sponsored by the Federation of British Industries was held at Birmingham on March 25. The morning session, over which Sir Ernest Canning, vice-president of the Federation, presided, was devoted to "Research and Economic Recovery", and Sir Ernest, in opening the Conference, emphasized the vital importance of research, not merely in the evolution of new materials, processes and products, but also in the improvement of existing processes and products. He pointed out that it is a vital factor in promoting the more effective use of materials, labour and power, thus saving coal and other fuels; and while in the short term we must all work harder, the only long-term method of restoring our pre-war standard of living lies in the persistent application of the scientific method and scientific advances to our industrial technique and life. We cannot equip ourselves for the highly competitive struggle in the world's markets which in two or three years will follow the sellers' market if we postpone the prosecution of industrial research until the time when the application of its results is essential to strengthen our competitive power.

In his paper on "Industrial Research and the National Economy", Sir William Larke commented on the document "Economic Survey for 1947" that in industry alone resides the power of making good the shortages and the responsibility of obtaining maximum production from the resources of fuel, raw materials and man-power which the Government is largely responsible for making available for industry. He urged that the scientific method must be applied throughout, starting at the level of the boards of directors. Sir William referred particularly to the possibilities in the saving of fuel by technical investigation and control, the economies in the use of raw materials and the reduction of waste often achieved by technical research, and the contribution of technological investigation of processes and machine operation to the increase in output per man-year. These are short-term measures for immediate application, but the long-term measures, including fundamental research, are in some ways an even more important factor. Sir William believes that the technical colleges have a more important part to play than in the past, and he emphasized the need for a spirit of inquiry and the development of research-mindedness as a national characteristic.

In the second paper at this session, Dr. J. W. Jenkin dealt with Midland industries and their research needs. These industries are exceedingly varied and multifarious; but there are some common factors, and whether the work be mechanical or scientific, real progress can only come from a ruthlessly objective study of all relevant facts and creative thinking to find relations between them and to devise the crucial experiments. There appears to be a need for a closer link between the scientific work characterizing the newer industries and the engineering inventiveness common in the older. This can often be supplied by making the same persons responsible both for the research results and their translation into practice. The bridging of the gap between the discovery and its commercial exploitation, the development stage, should not be left as a spare-time activity of those primarily responsible for administration, production or sales. Men are needed with wide sympathies to direct research away from over-emphasis on a restricted field of technology into closer liaison with development.

Sir Edward Appleton presided over the second session of the Conference, which dealt with industrial research in the Midlands. He commented on the increasing readiness of many scientific workers in universities and technical colleges to place their knowledge at the disposal of industry, but at the same time thought that the encouragement of co-operative action through the research associations is the most effective means of supplying the particular scientific knowledge which industry requires. Mr. F. G. W. King, technical director of the Dunlop Rubber Co., Ltd., contributed a well-documented paper on Midland research organisations, activities and facilities, in which he suggested that since most of the industrial research in this large and varied region is carried out in the laboratories of the large firms, although related contacts spread all over the country, investigation of methods of increasing productivity, particularly the skilled study of flow production, and close co-operation between research units and their related groups in firms, research associations and universities are required, in addition to further research. Such co-operation should be facilitated by fuller documentation of the broad fields of the research, to give a general idea of the problems studied, and he suggested that the research secretariat of the Federation of British Industries might help in the organisation of such documentation. Research, moreover, would only be fully effective if its results were known and appreciated by other experts and skilled workers in the industry. Appendixes to Mr. King's paper include an analysis of industries in the Birmingham region, and lists of industrial research in progress in technical colleges and universities, either in the region or outside the region, when specially related to its industries. The information relating to the universities was taken mainly from the "Notes on Current Scientific Researches in the United Kingdom" prepared for the Royal Society Empire Scientific Conference last year.

The concluding paper of the Conference, by Mr. J. C. Pearce, dealt with the smaller Midland firm and its application of research. Mr. Pearce suggested that the firm not large enough to provide one full-time or part-time technical man to act in liaison with outside developments should treat its research association as a source of information and apply for information as and when required. It should give the staff of the Association opportunities of assessing the nature of its work and problems so that replies can be suited to its ability to give effect to them. The research associations should treat this information from individual firms as strictly confidential, but use it to build up that part of the current research programme dealing with experimental work directed towards the solution of specific problems common to the industry as a whole or to sections of it. Mr. Pearce believes that the major functions of a research association, namely, the application of new knowledge through development and the dissemination of knowledge by intelligence activities, has been least satisfactorily solved.

In the discussion Mr. L. E. Lines, repudiating the suggestion that young industrial scientific workers should be excused military service, said that Great Britain is suffering from seeking too much security. Dr. Quarrel pointed out that this year we shall have only one fifth of the number of scientific recruits which was available to industry in 1938, and only one half of the average number for the war years. Sir William Akers, in summing up, said that some of the observations indicated that in certain directions planning by the Government has been very incomplete, and asked whether we should not now put all the technically and industrially fit people into the economic war.

OIL PLANTS IN EAST AFRICA

THE plan for mechanized production of ground nuts in East Africa described in the recent Whit Paper (Cmd. 7030) and the inherent importance o all oleaginous crops to-day give added interest to a informative and well-documented review of oil plant in East Africa by A. Glendon Hill, director of th East African Agricultural Research Institute (*E. Afr Agric. J.*, 12, 140; 1947). It deals with ground-nuts sesame and sunflower.

Ground-nuts. One of the most valuable of oil plants with an oil content of nearly 50 per cent in th shelled nuts, it is widely grown by natives in Eas Africa, mainly for their own food; though it ha not hitherto attracted the European farmer to an extent. In addition to oil, the nuts are rich in protein (about 30 per cent), so that after extraction o the oil the press cake forms a valuable cattle food Mr. Glendon Hill thinks this cake may in future b largely used for manufacture of artificial wool suc as 'Ardil'. The main ground-nut areas of East Afric are the western, central, lake and southern province of Tanganyika, the eastern province of Uganda, an the Nyanza and coast provinces of Kenya. Only small proportion of the crop is exported—21,000 ton in 1942. In 1936, 290,000 acres in Tanganyika an 167,000 acres in Uganda were under ground-nuts and in 1944 it was estimated there were 400,00 native growers in Tanganyika.

Types and varieties, soils and manures, cultivatio harvesting, diseases and pests, and crop economic are described. There are a great number of varietie which can be grouped into three main types, of whic the 'bunch' or 'upright' is the most desirable, a exemplified by Virginia Bunch, which is earl drought-resistant, gives good yield and oil conten but has hard shell. Spanish Bunch is even earlier, but with smaller yield. The ground-nut responds markedly to plant selection, which has been done in East Africa for some years with occasional notable success; for example, in evolving wilt-resistant strains. As it is not a self-fertile plant, selection and isolation of new strains is comparatively easy. Selection has been mostly directed to high yield and kernel percentage, with resistance to rosette disease; but not, so far as is known, to evenness in ripening—lack of which often causes serious trouble in harvesting—or to long dormancy and high oil content. In Uganda, bunch types are encouraged, but selection is proceeding with creeping types owing to their resistance to locusts. Selection has resulted in higher yielding varieties in some areas; but owing to the varying behaviour of different selections depending on season, final choice is difficult. In Nigeria, selection over five years resulted in 25 per cent yield increase in bunch type and 16 per cent in creeping type. Work with existing East African types is thought to be better than with imported varieties.

The best soils are light, sandy, well-drained loams, not too rich in organic matter; addition of lime and phosphate is often beneficial. The ground-nut fits in well with several different rotations, including cotton and maize. Fairly close spacing to keep the ground well covered is important, and weeds are often allowed to grow for this purpose. Yields per acre vary enormously according to conditions: from 200 to 2,200 lb. unshelled on native farms, though the average is nearer 600 lb., which is slightly less than the yield obtained in the United States. Mechanized farming in Queensland gives 3,600 lb. unshelled.

Sesame (simsim, ufuta, gingelly, bene, or til) has also high oil content, usually about 50 per cent, but sometimes much higher, with about 20 per cent protein and 18 per cent carbohydrate. Calcium content in the undecorticated product is remarkably high (1 per cent, mostly in the seed-coat), while phosphorus is 0·7 per cent. The main sesame areas in East Africa are: southern province of Tanganyika, northern province of Uganda, and Nyanza province of Kenya. It is mostly grown by native farmers for their own use, and the average yield is 350–400 lb. per acre. Care has to be taken not to contaminate with wild sesame (*S. radiatum* or *Ufuta mwitu*), which contains a substance toxic to cattle. There are many varieties, but the principal types are white and black. In Uganda, selection has aimed at high-yielding white-seed types for export, and has resulted in some improvement; as also in Tanganyika. Soils and climate, cultivation, harvesting, storage, pests, etc., are described. From the economic point of view, the yield from sesame is only about one third that of ground-nuts, and it is a major crop only where soils are sticky and make ground-nut harvesting expensive. It does not interest European farmers greatly.

Sunflower. As is well known, this crop covers vast areas in the U.S.S.R., and to a less degree in the Argentine, the Balkans, and China. It is not grown to any large extent in Africa. The best known in the past have been the giant types with heads 12–22 in. across, but easily sensitive obviously to wind and rain. A dwarf type has been introduced in Britain and elsewhere, such as the Pole Star, Southern Cross, Jupiter, and Mars. Attempts are being made to obtain seed of these varieties for trial in East Africa; but whether it is economically feasible there depends on world prices. Some notes on cultivation, etc., are given.

CHANK MARKING EXPERIMENTS AT TUTICORIN

FOR the purpose of ascertaining the migrations and growth-rate of the chank, marking experiments were begun in 1931 by the Madras Fisheries Department*. Since then about 5,000 chanks have been marked and liberated on the chank beds of Tuticorin. It was thought that there might be a migration of chanks from those beds to the Ceylon beds on the other side of the Gulf of Mannar. The experiments have shown that such migrations do not take place; but there are movements of chanks from one bed to another in the immediate vicinity. The greatest distance covered by any marked chank was nine miles.

There is marked variation in observed rates of growth, some specimens showing very little increase over long periods, while others have grown as much as 23 mm. in length in 23 months. The reason for this disparity is not known, but the suggestion is made that it may be due to variations in hydrological and other conditions on the different beds. This is a fairly safe guess, but it is no more than that. Much more work will have to be done and the data handled much more carefully and expertly before a sound knowledge of the bionomics of the chank can be acquired. It should not be necessary to state, for example, that of the 5,000 odd chanks that have been marked "only *about* 259 were recovered". Chanks are by no means minute animals, and the exact number recovered by the investigator must surely be known and should be recorded and reported upon with equal accuracy. In the absence of such accuracy little reliance can be placed upon any results obtained or conclusions reached.

Moreover, no scientific investigator should send out a paper in which only the local (common) name of the organism under investigation is given. Presumably the chank referred to in this paper is the gastropod *Turbinella pyrum*, Linn., but nowhere is this stated.

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* Preliminary Study of the Chank Marking Experiments at Tuticorin. By K. Chidambaram and M. Mukandan Unny. A paper read before the Zoological Section of the Indian Science Congress, January 1947.

FORTHCOMING EVENTS

Monday, May 12

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. Martin Jones: "Ley Farming and the Livestock Population".

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. H. Leech: "The Work of the Sub-Marine Section during the War".

Society of Public Analysts and other Analytical Chemists, Biological Methods Group (in the West Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 6 p.m.—Symposium on "The Production and Care of Laboratory Animals", Part 3. Dr. J. I. M. Jones and Dr. Eric C. Wood: "Housing"; General Discussion on all subjects.

Tuesday, May 13

Electrical Association for Women (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 10.30 a.m.—Fourteenth Annual General Meeting.

Zoological Society of London (at Regent's Park, London, N.W.8.), at 5 p.m.—Scientific Meeting.

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Future Trend of Component Design for the Services" (to be opened by Dr. G. W. Sutton and Mr. E. M. Lee).

Illuminating Engineering Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Annual General Meeting; at 6.30 p.m.—Dr. N. A. Halbertsma: "International Relations in Illuminating Engineering".

Society of Instrument Technology, North-West Section (at the College of Technology, Manchester), at 7.15 p.m.—Annual General Meeting; Dr. J. Yule Bogue: "The Measurement of Non-Cyclical Biological Phenomena".

Wednesday, May 14

British Glaciological Society (in the Department of Geography, Downing Place, Cambridge), at 5 p.m.—Discussion on "Glaciological Research in the Antarctic".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal College of Surgeons (at Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Prof. F. Wood Jones, F.R.S.: "The Hallmarks of Humanity" (Arris and Gale Lecture).

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. C. Störmer: "Mother-of-Pearl Clouds".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Mr. Alfred C. Bossom: "Economic Reconstruction, 8, Britain's Economic Future".

British Association for the Advancement of Science (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. E. D. Adrian, O.M., F.R.S.: "The Sense of Smell" (Alexander Pedler Lecture).

Institution of Electrical Engineers, Transmission Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. Waldemar Borgquist: "Recent Research and Development Work in Sweden on High-Voltage A.C. and D.C. Power-Transmission".

Royal Statistical Society, North-Eastern Group of the Industrial Applications Section (at the Newcastle Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne), at 6.30 p.m.—Mr. Glen Wortley: "The Use of Statistical Methods in Steel Production".

Wednesday, May 14—Friday, May 16

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1).—Annual General Meeting.

Wednesday, May 14

At 10 a.m.—Symposium on "The Hardenability of Steel"; at 8.30 p.m. (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Dr. C. Sykes, F.R.S.: "Steels for Use at Elevated Temperatures" (Second Hatfield Memorial Lecture).

Thursday, May 15

At 9.55 a.m. (at the Institution of Civil Engineers).—General Meeting.

Friday, May 16

At 10.30 a.m. (at the Institution of Civil Engineers).—General Meeting.

Thursday, May 15

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 4 p.m.—Annual General Meeting; Prof. W. R. Jones: "Geographic Changes in Mineral Producing Centres" (Presidential Address).

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. P. M. S. Blackett, F.R.S.: "The Magnetic Field of Massive Rotating Bodies".

Chemical Society, Sheffield Section (joint meeting with the Sheffield University Chemical Society, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. B. Speakman: "Some Relationships between the Structure and Properties of Natural and Synthetic Fibres".

Royal Statistical Society, Tees-side Sub-group of the Industrial Applications Section (at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough), at 6.30 p.m.—Mr. W. L. Stevens and Mr. J. T. Richardson: "Statistical Control and Factory Costs".

Institution of Structural Engineers, Lancashire and Cheshire Branch (in the Reynolds Hall, College of Technology, Manchester), at 7 p.m.—Annual General Meeting.

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 8 p.m.—Discussion on "Amœbiasis" (to be opened by Dr. C. M. Wenyon, F.R.S.).

Friday, May 16

British Rheologists' Club (joint meeting with the Chemical Society, at the Washington Singer Laboratories, University College of the South-West, Exeter), at 2.15 p.m.—Discussion on "The Chemistry and Rheology of Clay Systems" (to be opened by Dr. G. Nagelschmidt and Mr. H. H. Macey).

Chemical Society, Manchester Section (joint meeting with the Local Sections of the Society of Chemical Industry and the Royal Institute of Chemistry, in the Chemistry Lecture Theatre, The University, Manchester), at 6 p.m.—Dr. G. M. Dyson: "A New Notation for Organic Chemistry".

Sheffield Metallurgical Association (joint meeting with the Royal Institute of Chemistry and the Microchemistry Group of the Society of Public Analysts, in the Chemistry Lecture Theatre, The University, Western Bank, Sheffield), at 6 p.m.—Scientific Papers.

Institution of Electronics, N.W. England Section (in the Reynolds Hall, College of Technology, Manchester), at 6.45 p.m.—Mr. A. Levins: "Radar Navigation".

Institute of Economic Engineering (at Cowdray Hall, 1a Henrietta Place, London, W.1), at 7 p.m.—Mr. A. W. Willsmore: "Practical Problems of Production Control".

Women's Engineering Society (at 35 Grosvenor Place, London, S.W.1), at 7 p.m.—"Women in Post-War Engineering".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Pasture Research Officer for Kenya—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (May 17).

Lecturer in Neurology at Manchester Royal Infirmary—The Registrar, The University, Manchester 13 (May 19).

Lecturer in Chemistry and a Lecturer in Biology—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11 (May 21).

Bacteriologist—The Secretary, Glasgow Royal Infirmary, 135 Buchanan Street, Glasgow, C.1 (May 22).

Assistant Lecturer (Grade III) in Mechanical Engineering, Assistant Lecturer (Grade III) in Civil Engineering, and Assistant Lecturer (Grade III) in Fluid Mechanics—The Registrar, The University, Liverpool (May 23).

Lecturer or Senior Lecturer in Electro-Technics—The Registrar, The University, Manchester 13 (May 24).

Senior Clinical Photographer—The Secretary and Registrar, The University, Bristol (May 24).

Lecturer in Civil Engineering—The Secretary, Queen's University, Belfast (May 24).

Assistant Keeper in Entomology in the Manchester Museum—The Registrar, The University, Manchester 13 (May 26).

Assistant Lecturer (Grade III) in the Department of Geology—The Registrar, The University, Liverpool (May 27).

Chief Photographer—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (May 30).

Professional Officers in the Veterinary Branch of the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (May 31).

Analytical Chemist, and a Physical Chemist, in the Senior Scientific Officer grade in the Chemical Research Laboratory of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1866 (May 31).

Research Fellowship in Pure Science, and a Research Fellowship in Arts—The Secretary, University of Durham, 38 North Bailey, Durham (May 31).

Senior and Junior Research Fellowships—The Director, Atomic Energy Research Establishment, Harwell, Didcot, Berks. (May 31).

Lecturer in Civil Engineering, a Lecturer in Mechanical Engineering, and a Lecturer in Engineering Drawing and Design, in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (May 31).

Ramsay Memorial Fellowship for chemical research—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (May 31).

Reader in Pathology—The Secretary and Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (May 31).

Curator and Deputy Curator for Horniman Museum, London Road, London, S.E.23, and a Curator for Geffrye Museum, Kingsland Road, London, E.2—The Education Officer (Estab. 2), County Hall, London, S.E.1 (May 31).

Lecturer in the Department of Bacteriology—The Registrar, The University, Liverpool (May 31).

Senior Entomologist and Assistant to carry out investigations into the control of midges in Scotland—The Secretary, Scientific Advisory Committee, Department of Health for Scotland, St. Andrew's House, Edinburgh 1 (May 31).

Chair of Physiological Chemistry, and an Assistantship in Electrical Engineering—The Secretary of the University Court, The University, Glasgow, W.2 (May 31).

Assistant Lecturer (Grade III) in the Department of Geography—The Secretary, University College, Gower Street, London, W.C.1 (May 31).

Lecturer and Chief Assistant in Public Health—The Registrar, The University, Leeds 2 (May 31).

Leverhulme Studentships in Chemical Engineering—The Secretary, University College, Gower Street, London, W.C.1 (June 1).

Coke Research Fellowship—The Registrar, The University, Sheffield (June 1).

Lecturer in Bacteriology in the Dental School—The Registrar, The University, Manchester 13 (June 2).

Assistant Lecturer in Physics, and an Assistant Lecturer in Mathematics—The Registrar, University College of South Wales, Cathays Park, Cardiff (June 8).

Assistant Civil Engineers for the Directorate General of Works—Under-Secretary of State (S.2(h)), Air Ministry, Cornwall House, Stamford Street, London, S.E.1.

Engineer (British) in the Recording Section of the Research Department of the B.B.C.—Engineering Establishment Officer, Broadcasting House, London, W.1.

Senior Assistant in the Department of Metallurgy—The Principal, Central Technical College, Suffolk Street, Birmingham 1.

Senior Laboratory Steward in the Chemistry and Biology Department—The Registrar, Municipal College, Portsmouth.

Senior Technician in the Department of Anatomy—The Secretary, St. Mary's Hospital Medical School, London, W.2.

Senior Technician in the Pathological and Bacteriological Laboratory—The Medical Superintendent, Dudley Road Hospital, Birmingham 18.

Physical Chemist to conduct research on corrosion problems—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Chemistry Department'.

Research Manager, and Chemists and Physicists on the research staff—The Director, Paint Research Station, Waldegrave Road, Teddington, Middx.

Indian Science News Association
Office of Science & Culture
Calcutta

NATURE

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TECHNICAL COLLEGES AND INDUSTRIAL RESEARCH

IN his paper "Industrial Research and the National Economy" at the Midland Regional Conference of the Federation of British Industries on March 25, Sir William Larke stressed the important part which the technical colleges of Great Britain should play in the conduct of technical research. Mr. F. E. W. King, in a review of the Midland research organisations at the same Conference, commented on the comparative neglect of research by the technical colleges in the past, and suggested that the implementation of the recommendations of the Percy Report on Higher Technological Education should do much to remedy this position. More recently, at the Scottish Regional Conference of the Federation of British Industries, on April 25, Dr. W. M. Cummings also referred to the assistance which the technical colleges could give to industry, both in the way of technical research and in consulting work.

Dr. Cummings went on to urge the need for closer contact and better mutual understanding between the technical colleges and industry in Britain, and although his remarks related more particularly to chemical industry in Scotland, it is clear from the report on "Industrial Research in Technical Colleges", to which Sir William Larke referred in his paper at Birmingham, that much of what Dr. Cummings said is true of all subjects and throughout Great Britain. This report, by a special sub-committee of the Industrial Research Sub-Committee of the Federation of British Industries which was appointed "to consider the results of a survey on the industrial research activities of Britain's technical colleges and the Ministry of Education's future plans for industrial research in technical colleges; to report on the possibility of co-operation by industry and the form such co-operation might take", shows that, of the fifty-seven technical colleges selected from approximately two hundred by the Ministry as likely to provide positive answers, thirteen were not carrying out research, twenty-nine, including the majority of the senior technical colleges, were carrying out some research, and in only fifteen colleges were more than five persons engaged in research. About ten of the colleges possess special equipment of value for industrial purposes; all have close links with industry, and all but two possess satisfactory libraries. About 250 research workers, of whom about 160 are staff, were reported in the returns in this category, as against 72, of whom 52 are staff, in the returns from the twenty-five colleges in the second category.

The overall picture gained from the survey of the most active colleges is one of progressive development, handicapped by inadequate facilities and equipment, and by lack of staff. Moreover, in only seven of the fifty-seven colleges questioned do research scholarships exist, although there are grants from the Department of Scientific and Industrial Research to individual investigators and a few endowments from industry. Again, where there is close contact with local industry, it is normally through heads of departments, who act from time to time in a consultant capacity. Frequently, testing for local industry is carried out by technical colleges, often with specialized equipment for the purpose. Development work in assisting in the application of the results of research is limited mainly to the special war-time requirements of local firms, and contacts with the research associations and the Department of Scientific and Industrial Research are limited and spasmodic.

Commenting on the position revealed by the survey, the Sub-Committee, which consisted of Sir Robert Pickard (chairman), Dr. W. T. K. Braunholtz, Sir Arthur Fleming, Mr. Edward Meigl and Dr. B. J. A. Bard as secretary, considers that the amount of research carried out, and the extent to which the technical colleges are assisting local industry in the way of research, development or advice, are inadequate when measured either in terms of the resources and potentialities of technical colleges or the requirements of industry. Moreover, it holds that industry is not, and has not been, made sufficiently aware of the facilities that exist in technical colleges, or the assistance they can provide in the solution of industrial problems and in the application of scientific knowledge for the benefit of local industry. More particularly, since the imparting of knowledge cannot be separated from its advancement, if teachers are to maintain their enthusiasm, and the right type is to be attracted to the profession, the Committee urges that opportunity for research by the teaching staff should be a *sine qua non* in all senior technical colleges, and that opportunity should simultaneously be provided for graduates and students to participate in original investigations related to local needs and interests.

On the scope of such research the Committee recognizes that the primary responsibility of the technical college is to train men for technical positions in industry, and that accordingly any research prosecuted should bear some relation to this objective. The training of men for research posts in industry, however, is not necessarily outside the function of the technical college; and on the other hand, carrying out industrial investigations may assist members of the staff of the technical college to keep up to date in their knowledge of industrial practice and thus relate their teaching more closely to industrial needs. So far as long-range fundamental research is concerned, the Committee believes that such research is best carried out at a university or independent institution, or by an industrial research association; although on occasion such investigations may be suitable for technical colleges if they are adequately staffed and equipped.

As to actual research for local industry, the Committee endorses the views expressed by the Ministry of Education last year in Circular 94; but it suggests that investigations of which a manufacturing concern offers to bear the full cost, with a proviso prohibiting or restricting publication of results, should be considered with regard to the possible benefit to the college. Similarly, in regard to consultation with local industry, the Committee endorses the principles laid down in the statement "Principles suggested for a Code of Practice in respect of consulting and similar work accepted by members of whole-time academic staff" which was approved and issued last year by the Board of the Institute of Physics and the Council of the Royal Institute of Chemistry.

The Committee believes that the plans for encouraging research in the technical colleges outlined in the Ministry of Education's Circular lay a sound foundation, and most of the colleges have plans in hand for expanding their research effort. It is, nevertheless, considered that industry can contribute to the success of research work at technical colleges, and that this in turn will benefit industry itself. Industry should take increasing interest in the technical college, not only as a place where staff can be trained, but also as a centre which may be of supplementary assistance to the research activities of the industry and the private consultant in the solution of both general and particular industrial problems. Accordingly, the report recommends that industrial concerns with their own research departments should, wherever possible, place research work with their local technical college, and consult the college when an outside opinion or specialized advice within its competence is required. They should also provide financial help and equipment where required, to increase the capacity for service to industry, arrange for interchange of staff, for vacation and refresher courses and works visits from time to time, encourage the organisation by the college of a reference library and information service related to its field of activity, and generally develop the closest possible relations for their mutual benefit, including active participation on the governing body.

Each trade association should ascertain which technical colleges in Great Britain can be of assistance to the industries it represents, and should assist financially in the provision of equipment or personnel where necessary, as well as maintain contact with regional education councils and local education authorities.

The Industrial Research Secretariat of the Federation of British Industries, the Committee suggests may well play a constructive part in bringing industry and technical colleges into closer contact for the solution of industrial problems; and the two regional conferences which the Federation has organised since this report was signed are steps in the right direction. The Secretariat can act to some extent as a clearing house, though the Intelligence Division of the Department of Scientific and Industrial Research should be equally effective, and care should be taken to avoid overlapping and duplication of effort. The Federation's Industrial Research Secretariat would rightly welcome any approach from a technical college to obtain information or make research or industrial contacts, or with regard to the initiation of staff exchange schemes; indeed, there should be a wide field in which there is little risk of duplicated effort. Moreover, the appendix (dated January 1, 1947) listing technical colleges with research activities and facilities likely to interest industry indicates that in the way of information much co-operative effort is still required to fill the gaps in systematic knowledge.

The information in this list was supplied by the Association of Principals of Technical Institutions. It is somewhat fuller than that contained in the lists of industrial research in technical colleges and at the universities appended to Mr. J. G. King's paper on Midland research organisations read at the Midland Regional Conference of the Federation last March, which was derived mainly from the Federation's own records or from the "Notes on Current Scientific Researches in the United Kingdom" prepared for the Royal Society Empire Scientific Conference last year; but neither list is complete, and the approval with which the "Notes" were received at the Empire Scientific Conference shows how warmly such an authoritative and comprehensive compilation would be welcomed. Naturally it could never be entirely up to date, but if maintained by the appropriate bureau it should do much to assist contact between industry and the technical colleges and also the universities, and especially to help the technical colleges to plan their own research.

The report of the Federation of British Industries Sub-Committee is chiefly of value as indicating the approval by an important section of industry of certain current trends of opinion in educational and professional opinion, as reflected, for example, in the Ministry of Education Circular and in the Code of Practice issued by the Joint Council of Professional Scientists; but beyond showing that the Federation is aware of the possibilities of the educational work it could undertake in promoting contact between the technical colleges and individual firms, and that it is prepared to use those opportunities to the full, the report contains little in the way of constructive proposals. Moreover, there are some important omissions. There is no reference to recent developments, such as refresher courses, which can indeed prove as valuable to the teacher in the technical college as to the staff of an industrial firm. The Joint Research Council established in Manchester, too, may well become, as Dr. W. H. Cummings suggested at Glasgow, the prototype of what is required in other regions to facilitate contacts between both technical colleges and the universities and local industry.

On the proposals of the Percy Report on Higher Technological Education the Committee makes no comment, and its survey of the relations between technical colleges and the universities, seems to be somewhat superficial. The Percy Committee missed an opportunity when it concerned itself exclusively with the needs of engineering and failed to compare the needs and experience, for example, of the engineering and chemical industries, and the present report takes rather too narrow a view of the training of the staff in the technical colleges. The only really satisfactory way for such teachers to keep up to date in the industrial technique of their particular subject is for the teacher to return to industry for substantial periods. The conduct of subsidized *ad hoc* investigations for industrial firms in the laboratories of a technical college is unlikely of itself to meet that need, yet the report gives no indication of the views of the Committee as to how such interchange should be encouraged. Satisfactory as the report may be so far as it goes, and rightly as it emphasizes the opportunities for research which the technical colleges could offer, on the whole the Committee has approached the subject too timidly, and has failed to define sufficiently clearly the relative functions of the universities and technical colleges; it has overlooked the importance of free interchange between the technical colleges and the universities, and between both these and industry, and has confined itself to the general point that research could be carried out more extensively at the technical colleges, without indicating the character of the investigations which it is reasonable to expect the technical colleges to be equipped to pursue. There is little attempt to define clearly the conditions on either side for closer co-operation. By contrast, Prof. Edmund Giffen's inaugural lecture at Queen Mary College, London, on "Engineering Research in the University" (Oxford University Press, London, 1946. 1*s.* 6*d.* net) is marked by clear thinking on fundamental aspects. One would have welcomed comments from the Federation of British Industries' Sub-Committee on Prof. Giffen's suggestions, and more particularly on the scheme he proposes for co-operation between the universities and research associations. Such a scheme should be equally applicable to the technical colleges and to fields other than that of engineering; but the inherent weakness of the research association movement itself renders further industrial contact essential if the technical college is to reap the full benefit of intimate contact with the most recent advances in industrial practice and technique. Here the joint research council on the lines of that at Manchester might contribute something, and it is to be hoped that the promised report from the Parliamentary and Scientific Committee on schools and colleges of technology in Great Britain in relation to scientific and technical man-power will take the matter a stage further, and deal more imaginatively and constructively with these important questions.

NEW LIGHT ON VESALIUS

A Prelude to Modern Science

Being a Discussion of the History, Sources and Circumstances of the "Tabulae Anatomicae Sex" of Vesalius. By Charles Singer and C. Rabin. (Publications of the Wellcome Historical Medical Museum, New Series, No. 1.) Pp. lxxxvi+58+6 plates. (Cambridge: At the University Press, 1946.) 45*s.* net.

DR CHARLES SINGER has celebrated his seventieth birthday by the publication of one of his most important contributions to the history of science. The works of Vesalius have attracted more attention, and have been more intensively scrutinized, than those of any other anatomist, and it might well be thought that there was nothing more to be said. It is true that we still await an English translation of the "Fabrica", but even this monumental and baffling task is approaching completion in the United States. Now Dr. Singer has raised Vesalian commentary to so erudite a plane that his successors must perforce master the technique of the higher criticism if their labours are to command attention and respect.

In this work Dr. Singer has secured the collaboration of Dr. C. Rabin—a name new to students of the history of science. He is assistant to the professor of Arabic in the University of Oxford, specializing in comparative Semitic philology, and the contribution to the volume of such a scholar obviously adds much to its content and importance. Dr. Singer himself, however, has devoted many years to the study of Latin anatomical and medical terms which had a Semitic origin. The plan of this "Prelude to Modern Science" includes the following sections: (1) character and purpose of the "Tabulae Sex", printed in 1538; (2) Vesalius and the schools of Louvain and Paris; (3) Italian predecessors of Vesalius; (4) Galenic physiology and its Latin presentation; (5) certain anatomical elements of the Tabulae (for example, reliance of Vesalius on animal anatomy, rete mirabile, etc.); (6) Renaissance anatomical vocabulary; (7) Semitic elements in the Tabulae; (8) translation of and commentary on the Tabulae; (9–12) general, Greek, Arabic and Hebrew indexes and reduced facsimiles of the six plates of the Tabulae.

The authors regard the "Fabrica" of Vesalius, published in 1543, as "the first great achievement of modern observational science. It opens a new scene as with the quick rise of a curtain, for it is suddenly, essentially and brilliantly modern—modern in appearance, modern in outlook, modern in method, modern in its art and in its technique. And modern, too, in what it omits no less than what it includes. It is a startling apparition in the very midst of that imitative world of the revival of classical learning which still pervades its language." Yet the Tabulae Sex, printed only some five years earlier, is quite different in outlook, and is inspired by Galen and medieval tradition even to the extent of grafting the rete mirabile of an ungulate on to the arterial system of man. The explanation of this contrast constitutes a 'Vesalian problem', of which the authors produce a convincing solution. They point out that by the sixteenth century medicine was deeply committed to the acceptance of hypothetical entities "the separate existence of which no one could verify and, therefore, no one would deny". It had become, indeed, highly astrological. A very young man such as Vesalius was at the time could scarcely fail in his early work to be influenced by current obsessions; but his reaction to the call of factual anatomy, as embodied in the later "Fabrica", "gave in a trice a new and far more positive basis to medical thought. In the course of a very few years medicine was to become anatomical. Observational science was thus born with the shortest of birth pains."

One of Vesalius' most inspiring successes was his exploitation of the graphic method of teaching anatomy, and if he did not initiate this method he was the first to demonstrate that it was an indispensable adjunct to the study of animal structure. It is generally accepted that the figures in the "Fabrica" were the work of Calcar, a pupil of Titian. The present authors agree that the three skeletons of the Tabulae "are certainly by Calcar", but that they compare so unfavourably with the corresponding figures of the "Fabrica" that it is "unlikely" that Calcar played more than a minor part in the illustration of that work. "With these plates [of the Tabulae] Calcar effectively disappears from the anatomic scene, nor does he, in doing so, shroud himself in a cloud of glory." It is suggested that the artist of the "Fabrica" "was a young man, unknown to fame, who died before the book was printed".

The authors give us a detailed and enlightening picture of the early days of Vesalius and of the forces which moulded him during his stay in Belgium, France and Italy. Thus in the thirties his early researches had as their driving motive the verification of Galen; but in the forties he had realized that his Paris masters, Guenther and Sylvius, "were almost indifferent to dissection and were enthusiasts only for what Galen had written". Therefore, to achieve his purpose he must put his own hand to the business. Nevertheless, as the authors point out, the break with Galen took longer than he would have us believe, and it is only in the "Fabrica" that he is revealed as a discoverer, and as a "modern man of science with a rovingly enquiring mind and the habit of presenting his own findings in pictorial form". In this connexion an examination of Galenic physiology is called for and given, and we have an admirably clear and informative statement of Galen's views on the movements of the blood, illustrated by a useful diagram.

The failure of Vesalius to admit that his descriptions are often based on animal and not on human anatomy has been revealed by a number of authors, but never so critically as in the present work. It is an almost inexhaustible topic of discussion, and the authors attack it in no carping spirit, but with a sympathetic understanding of the difficulties of the period. They point out that, but for the unfortunate element of deception involved, the animal approach to human anatomy should be counted for righteousness in those who practised it, and that when the Padua professors abandoned the comparative method the greatness of their school faded with it. They admit that Vesalius must certainly have dissected far more animals than men, but add that certain anatomical features are more profitably investigated in animal bodies than in human. Many structural details were examined at first hand by Dr. Singer himself in his critical and fascinating attempt to determine how much of the "Tabulae" and "Fabrica" is to be assigned to animal, and how much to human, anatomy. More remains to be done under this head, and Dr. Singer's results are too striking to remain without companions. The following are the main points so far elucidated: rete mirabile; position and form of the heart; branches of the aortic arch; the caval systems; posterior intercostal vessels; relative levels of kidneys and renal vessels; lobes of the liver; genital organs of both sexes; prostate gland; asymmetry of spermatic veins; segments of sternum.

The introductory matter concludes with a scholarly essay of twenty-one pages by both authors on the anatomical vocabulary of the Renaissance and the Semitic elements in the "Tabulae". The modern history of anatomical terminology may be said to have begun in three works by Joseph Hyrtl, published in 1879, 1880 and 1884, of which the second is the most important. All, however, now need revision, and the present essay points to its authors as the source from which this comprehensive revision should come. They have already done much, but as the "Tabulae" do not include the viscera the entire field has yet to be covered before a substantial vocabulary of medieval anatomy can be attempted. In the meantime, the general index of the present work, combined with the text, provides us with an analysis of medieval Latin medical and anatomical terms, many of which are still employed, of the greatest value and interest.

Probably most students who are not masters of Eastern languages will value particularly Part 8 of the work, which is an English translation of the "Tabulae Sex", accompanied by 343 exhaustive annotations, and photographic reproductions of the six plates and Latin text. Of the "Tabulae" two complete sets of the original issue are all that have survived, but there are three facsimile editions, only one of which, however, is readily procurable. Now all interested can possess this excellent facsimile copy, which for the purposes of research is as good as the original, and for which we must express our thanks to the authors and also to the Wellcome Historical Medical Museum for undertaking the responsibility of production.

The book has been admirably printed and bound, but exception must be taken to the abominable backing of the six plates. The general editor of the series, Dr. E. Ashworth Underwood, informs us that this was the only material at the printer's disposal, and it was therefore either that or nothing.

Drs. Singer and Rabin are to be warmly congratulated on an addition to Vesalian literature which will surely rank as a classic in times to come.

F. J. COLE

PHYSIOLOGICAL EMBRYOLOGY

Einführung in die Physiologische Embryologie
Von Prof. F. E. Lehmann. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften, 5.) Pp. 414. (Basel: Verlag Birkhäuser, 1945.) 38 Swiss francs.

THE years between the two World Wars saw a very rapid accumulation of experimental data bearing on the mechanism of development in many groups of animals, particularly the echinoderms and the vertebrates. By the end of the 1930's, most experimental embryologists felt the need for a synthesis, and the elaboration of a theoretical structure by which the facts could be held together in an illuminating way. The disturbances of the War necessitated a slackening in the pace of experimental work, and the leaders of most of the major schools of experimental embryology took the opportunity to try their hand at producing the necessary system of thought. Spemann, whose work provided the original inspiration for much of the recent progress, led off with his "Experimentelle Beiträge zu einer Theorie der Entwicklung" in 1936; then from America we were offered Weiss' "Principles of Development" in 1939, and Child's "Patterns and Problems of Development" in 1941; from Britain, Waddington's "Organisers and Genes" in 1940 and Needham's monumental "Biochemistry and Morphogenesis" in 1942; from Belgium, Dalcq's "L'œuf et son Dynamisme Organisateur" in 1941 and Brachet's stimulating "Embryologie Chimique" in 1944. We are still waiting, not too patiently, for a similar thorough treatment from the point of view of the Swedish school of Runnström and Hörstadius.

It is in the setting of this series of works that Lehmann's "Einführung in der Physiologische Embryologie" will be studied. Prof. Lehmann is known as one of the earlier of Spemann's pupils, and for the last twenty years a steady stream of interesting and very thorough papers have issued from his laboratory in Switzerland, mostly devoted to the analysis of organiser action in the Amphibia. Two thirds of his book are devoted to this group of animals. In the remaining third he discusses the recent work, mainly Swedish, on the echinoderms. This restriction of his field enables Prof. Lehmann to describe the experimental data in considerably greater detail than was possible in most of the books mentioned above, and his work thus provides a summary of facts which will be very useful to the student.

In other respects the results of this policy of exclusion are not so happy. Although the two groups chosen by Lehmann are undoubtedly those in which our knowledge is fullest, yet there are many suggestions of considerable importance to be derived from studies on other animals. Moreover, the epigenetic system of the echinoderm egg is so different from that of the amphibian that a mere discussion first of one and then of the other produces rather two separate monographs than one unified book. The two systems can scarcely be brought into fruitful relation without some account of the spiral-cleaving invertebrates and the Prochordates; while the most direct illumination of the difficult problems in amphibian embryology must be derived from the birds and fish rather than from a group so far removed as the sea-urchins.

Our understanding of the epigenetic processes by which the organism is formed is still at a fairly early stage. The end-results are living animals, organs and tissues. These cannot yet be fully comprehended in physical or chemical terms; and it is thus impossible that a purely physico-chemical theory of development could be adequate. Nevertheless, the theoreticians of experimental embryology are presented with a choice—they may choose to emphasize the more specifically 'biological' aspects of their subject-matter, or they may decide to try to formulate concepts which, as it were, lead towards the realm of physico-chemical ideas. Much of the recent work has been inspired by the second tendency. Although Prof. Lehmann faithfully summarizes this, and indeed speaks highly of its value, his most characteristic ideas seem to belong rather to the former trend. This impression may be partly due to the arrangement of his matter, which he divides into the purely descriptive, the 'entwicklungsmechanisches', and the physiological, a scheme which means that the treatment of each question, instead of proceeding steadily from the biological towards the physico-chemical, is broken into separate parts located in different chapters. This dislocation tends to diminish the field to which the more physico-chemical ideas are applied. Similarly, Lehmann relies to some extent, as any author dealing with this material must do, on such essentially unclear notions as 'fields', gradients, and so on. But he sets this aspect of his theories in the centre of the stage, and goes out of his way to emphasize its organismic character by the frequent use of long German phrases full of overtones —"plastisches Blastemfeld" instead of plain 'field', "Organisatorblastem" for organiser, and such expressions as "topogenetischen begrenzte Selbstorganisation", "kombinative Einheitsleistung", and so on. This type of approach is one which does not appeal to the reviewer as much as does that of some of the other recent works; but it represents a necessary corrective to any possible over-confidence in the complete adequacy of biochemical embryology in its present state.

C. H. WADDINGTON

THE MAGNETIC FIELD OF MASSIVE ROTATING BODIES*

By PROF. P. M. S. BLACKETT, F.R.S.
The University, Manchester

Summary

IT has been known for a long time, particularly from the work of Schuster, Sutherland and H. A. Wilson, though lately little regarded, that the magnetic moment P and the angular momentum U of the earth and sun are nearly proportional, and that the constant of proportionality is nearly the square root of the gravitational constant G divided by the velocity of light c. We can write, in fact,

$$P = \beta \frac{G^{1/2}}{c} U,$$

where β is a constant of the order of unity.

For the first time, the magnetic field of a star, 78 Virginis, has recently been measured (Babcock, 1947). Using the best estimate available for its mass, radius and rotational velocity, the calculated value of the magnetic field agrees with its observed value. We have, therefore, a rough verification of the equation above for three bodies, the earth, sun and 78 Virginis, and covering a range of P and U of more than $10^{10}:1$, though only of 2,000 : 1 in measured field. It is therefore considered that the above equation must be taken seriously as a possible general law of Nature for all massive rotating bodies.

If white dwarfs are collapsed forms of stars like the sun, then they should have the same angular momentum and so, according to the equation above, the same magnetic moment. Owing to their small size, they will have a surface magnetic field of the order of 10^6 gauss. It is suggested that magnetic fields of this order may be in part the cause of the large breadth of the Balmer lines in many white dwarfs, and of the complete absence of any lines in some very dense ones. The various alternative theories of the magnetic field of the earth and sun are discussed. It is suggested tentatively that the balance of evidence is that the above equation represents some new and fundamental property of rotating matter. Perhaps this relation will provide the long-sought connexion between electromagnetic and gravitational phenomena.

1. The Magnetic Field of the Earth, the Sun and a Star

While considering the possible influence of the magnetic fields of stars in the galaxy on cosmic ray phenomena, I noticed two results which seemed to me of great physical interest. The magnetic moments P of the earth and the sun are nearly proportional to their angular momenta U, calculated from the expression

$$U = \frac{2}{5} \omega M R^2 \quad . \quad . \quad . \quad (1)$$

for a uniformly dense sphere of mass M, radius R and angular velocity ω. This proportionality can be seen from the figures in Table 1.

TABLE 1

Body	Mass M (gm.)	Radius R (cm.)	Angular velocity ω (sec.$^{-1}$)	U	H_P (gauss)	P	P/U
Earth	$6{\cdot}0 \times 10^{27}$	$6{\cdot}37 \times 10^8$	$7{\cdot}3 \times 10^{-5}$	$7{\cdot}1 \times 10^{40}$	0·61	$7{\cdot}9 \times 10^{25}$	$1{\cdot}11 \times 10^{-15}$
Sun	$2{\cdot}0 \times 10^{33}$	$6{\cdot}97 \times 10^{10}$	$2{\cdot}9 \times 10^{-6}$	$1{\cdot}12 \times 10^{49}$	53	$8{\cdot}9 \times 10^{33}$	$0{\cdot}79 \times 10^{-15}$

Measured values of the polar magnetic fields are also given. These are related to the magnetic moments by the expression

$$H_P = 2P/R^3. \quad . \quad . \quad . \quad . \quad (2)$$

It has long been known that the directions of rotation and of the magnetic moments of the two bodies are similarly related; in fact, in both bodies, the south magnetic poles are near the north geographical poles.

It was natural to compare the mean ratio $(P/U)_1$ of the magnetic moment to angular momentum of these two astronomical bodies with the similar ratio

$$(P/U)_2 = e/2mc = 0{\cdot}88 \times 10^7 \text{ cm.}^{1/2} \text{ gm.}^{-1/2} \quad (3)$$

for a Bohr magneton. We have

$$(P/U)_1/(P/U)_2 = 1{\cdot}08 \times 10^{-22}, \quad . \quad . \quad (4)$$

and one recognizes immediately that this numerical value is close to that of the well-known non-dimensional ratio

$$G^{1/2}\, m/e = 4{\cdot}90 \times 10^{-22} \quad . \quad . \quad (5)$$

of the gravitational mass of an electron to its charge in E.S.U. We can thus write

$$(P/U)_1 = \beta \frac{G^{1/2}\, m}{e} (P/U)_2, \quad . \quad . \quad (6)$$

where β is a small numerical constant of magnitude about 1/4; whence with (3) we find for the relation between the magnetic moment and angular momentum of both astronomical bodies

$$P = \beta \frac{G^{1/2}}{2c} U. \quad . \quad . \quad . \quad (7)$$

The simplicity of this result, either in the form (6) or (7), suggested that it must have some profound physical significance.

Stimulated thus to study the voluminous literature concerning the origin of the magnetic fields of the earth and sun, I found to my surprise that the essence of these facts had been known for many years, but had, for various reasons, dropped lately out of notice. A survey of this earlier work will be given in the next section.

Seeking a further test of equation (7), I thought at once of the possibility that the magnetic field of some rapidly rotating star might be measurable. I am indebted to Prof. S. Chandrasekhar for giving me early news of the first measurement of the magnetic field of a star that has ever been made. The measurements by Babcock[1] on 78 Virginis have now been published and give a polar field of 1,500 gauss. To calculate P and U we require its mass, radius and angular velocity. From statistical evidence on stars of similar type, the probable values of these quantities in terms of the values for the sun are found to be $M = 2{\cdot}3$, $R = 2{\cdot}0$, $\omega = 25$ (see Section 4). Table 2 gives the resulting data for the star.

TABLE 2

Body	M	R	ω	U	H	P	P/U
78 Virginis	$4{\cdot}6 \times 10^{33}$	$1{\cdot}4 \times 10^{11}$	$7{\cdot}3 \times 10^{-5}$	$2{\cdot}6 \times 10^{51}$	1500	$2{\cdot}1 \times 10^{36}$	$0{\cdot}81 \times 10^{-15}$

We find again about the same ratio for P/U, showing that (7) holds not only for the earth and sun but also for 78 Virginis. The relation between the directions of the rotation and the magnetic field is not known. This further support for the validity of (7) suggests, on one hand, that it must be taken seriously as a possible new general law of Nature, and on the other, that a more rigorous test of its validity must be made, taking into account the variation of density and possibly also of rotation inside the bodies.

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* Paper presented before the Royal Society of London on May 15.

2. Previous Theories of the Magnetic Field of the Earth and Sun

Though the main dipole field of the earth is known to be of internal origin, how it is produced is still obscure. A critical discussion of the extensive literature is given by Chapman and Bartels[2] (1940). The earlier surveys by Schuster[3] (1912), Brunt[4] (1913) and Swann[5] (1923) are still of great value. Possible theories of the sun's field are discussed in a recent paper by Cowling[6] (1945).

Theories of the main field of the earth or sun may conveniently be divided into two classes, which may be called *specific* and *general* theories.

A *specific* theory is one which attributes the magnetic properties of a rotating body to the specific properties of the matter of which it is composed; in such a theory the magnetic moment of a massive body would depend on the specific electrical, magnetic, thermal and mechanical properties of its material, and so is likely to have quite different values for bodies in different physical conditions.

The first theory of this kind, that the earth is ferromagnetic, has long been abandoned, since the internal temperature of the earth is almost certainly well above the Curie points of any materials likely to be present. The obvious alternative is to assume the existence of an electrical conduction current in the earth. The difficulty is to find a mechanism which will maintain it. To explain the sign of the field, a positive current must flow from east to west or a negative one from west to east.

A recent attempt by Elsasser[7] (1939) attributes the current to thermo-electric E.M.F.'s arising from temperature differences in the fluid core due to convective motions. The essential asymmetry required to produce a net circulation around the axis is attributed to the action of Coriolis forces on the convecting masses. In a subsequent paper Elsasser[8] (1941) discusses the relation between the main large dipole field of the earth and the irregular part which amounts to a few per cent of the main field. The origin of both is held to be in the central core of molten metal of radius about 0·55 *R*.

A rather similar theory by Frenkel[9] (1945) introduces in addition a self-excitation mechanism, such as had been considered by Gurevich and Lebedinsky[10] (1945) to be the origin of the magnetic field of sunspots. The first theory involving a self-excitation or dynamo mechanism was put forward by Larmor[11] (1919) and was elaborated in detail by Cowling[12] (1933) and shown to fail to explain either the magnetic field of sunspots or the main fields of the earth and sun. Cowling[6] (1945) showed, too, that thermal effects due to convection in the rotating sun give the right sign but in magnitude only 10^{-7} of the observed field. He also shows that the time of electromagnetic decay of the sun's general magnetic field is 10^{10} years, so that the field might be a relic from a different primeval state. But Lamb (for example, see Chapman and Bartel, ref. 2, vol. 2, p. 704) had shown long ago that the decay of currents in the earth would be far too quick to allow the field to be explained as a survival.

A *general* theory is one that attributes the dipole field to some general property of rotating matter. Already in 1891, Schuster[13], suspecting from the appearance of the solar corona that the sun might have a magnetic field, had put the question, "Is every large rotating mass a magnet ?"

The only obvious atomic effect of a general character is that of magnetization by rotation, that is, the gyro-magnetic effect. This gives the right sign, but a moment 10^{10} too small (ref. 2, p. 705). But, as Schuster showed[3], any such uniform magnetization gives a total moment proportional to the volume of the sphere and so a surface field which is independent of the radius. Thus any such theory can be excluded.

In a series of papers, Sutherland[14] (1900–8) assumed that the earth's magnetic field is due to its possession of a positive volume charge compensated by a negative surface charge. He calculated the charge density required and showed that it implies electric fields inside the earth of the order of 10^8 volts per cm. He also noticed that the separation of charges, as calculated from the observed magnetic field of the earth, had about the same magnitude as would occur if gravitation were explained, on the basis of Lorentz's pre-relativity theory (for example, ref. 3), as due to a slight difference between the electric forces between two protons, two electrons, and an electron and a proton. This is, in essence, an early recognition of the numerical result explicitly stated later by Wilson[15] (1923), which expresses in a rather different way the result already given in section 1.

In 1912, Schuster gave a survey[3] of the possible theories and their difficulties, and studied in some detail one similar to that of Sutherland, depending on the assumption of unequal forces between like and unlike atomic particles. Brunt[4] (1913) surveyed many different theories and also showed that the separation of positive and negative charges in the sun's gravitational field could not produce more than 10^{-15} of the sun's magnetic field.

H. A. Wilson[15] (1923), following a suggestion of Schuster[3], showed that one obtained the right order of magnitude for the fields of the earth and sun if one assumed that a moving mass element *M*, measured in gravitational units, has the same magnetic effect as a moving negative charge *Q* measured in E.S.U. The measure *M* of the mass of a body in gravitational units is defined by the equation $F = M_1M_2/r^2$ for the gravitational force between two masses. Comparing this with the expression $F = Gm_1m_2/r^2$, where m_1 and m_2 are measured in grams, we have $M = G^{1/2}m$, whence the gravitational unit of matter amounts to $G^{-1/2} = 3,870$ gm.

Wilson's hypothesis, expressed formally, amounted to the assumption that a mass element *m* gm., or *M* gravitational units, when moving with velocity *v* gives, at a distance *r*, a magnetic field,

$$H = -\frac{M}{cr^3}[v.r] = -\frac{G^{1/2}m}{cr^3}[v.r] \quad . \quad . \quad (8)$$

in analogy to the non-relativistic expression for the magnetic field of a moving charge *Q* E.S.U., which is:

$$H = \frac{Q}{cr^3}[v.r]. \quad . \quad . \quad . \quad . \quad (9)$$

From (8), we find by integration that the magnetic moment *P* of a sphere of mass *M* and uniform density ρ, radius *R* and angular velocity ω, is given by

$$P = \frac{1}{5}\frac{G^{1/2}}{c}\omega MR^2. \quad . \quad . \quad (10)$$

We note that (1) and (10) together give (7), apart from the constant β. The surface magnetic field at the pole is, from (2),

$$H_P = \frac{2}{5}\frac{G^{1/2}}{c}\frac{\omega M}{R}, \quad . \quad . \quad . \quad (11)$$

or expressed in terms of the density ρ

$$H_P = \frac{8}{15}\pi\frac{G^{1/2}}{c}\omega\rho R^2. \quad . \quad . \quad . \quad (11a)$$

Wilson showed that (11) gave the right ratio for the field of the sun and the earth, but numerical values about three times too great.

An alternative way of expressing this result is that the earth's magnetic field is such that would be produced if it possessed a volume negative charge density σ, given in terms of the mass density ρ by

$$\sigma \cong G^{1/2}\rho. \quad . \quad . \quad . \quad (12)$$

Angenheister[16] (1925) also stressed the fact that the assumption of an electric charge density proportional to the mass density gives nearly the correct ratio for the magnetic field of sun and earth. He clearly recognized the physical difficulties of assuming the existence of *real* charges of such a magnitude, and of the large electric fields which must accompany them, in an electrically conducting material such as the earth's core.

Wilson[15] (1923) made a laboratory experiment with a swinging iron bar to test his hypothesis that a moving mass produces a magnetic field. He showed experimentally that the field given by (8), assuming that m is taken as the mass of the earth and v the relative velocity of the iron bar, did not exist. Other arguments against the hypothesis are given in Section 5.

It was probably this disproof of the existence of the field given by (8) which led to the later lack of interest in the approximate validity for the sun and earth of the result expressed by (7). This difficulty about translational, as opposed to rotary, motion had already been discussed by Schuster in 1912, and will be taken up again in Section 5.

Schlomka[17] (1933) has treated in some detail a theory based essentially on Schuster's hypothesis of unequal long-range Coulomb forces between like and unlike particles.

Haalck[18] (1937–38) attributes the required charge separation not to a difference in the Coulomb forces between electrons and nuclei, but to the short-range forces between electrons and molecules, that is, to the forces responsible for the elastic properties of materials. He assumes that such forces would lead to a charge separation proportional to some power of the radius, with a maximum at the earth's centre.

Swann[19] (1927) worked out an elaborate theory based on a small arbitrary modification of the electro-dynamical equations, chosen so as to give the required magnetic field without the unwanted electric field. However, Swann's fundamental hypothesis was that the magnetic field of a rotating body was proportional to $\rho\omega^4 R^4$ rather than to $\rho\omega R^2$ as given by (11a). This was adopted to avoid the difficulty of translational motion by assuming that the magnetic field due to a mass element depended on certain time derivatives of its velocity, and so is zero for uniform translational motion. Swann chose this particular form since it does give correctly the ratio of the field of the sun and the earth. But it also predicts relatively large fields for rotating bodies on a laboratory scale, and these were later shown by Swann and Longacre[20] (1928) not to exist, thus refuting the theory at least for small bodies. Other objections to Swann's theory are that it is unlikely that the vector quantity P will depend on an even power of the vector ω, and that the theory in no way gives the correct numerical value of the magnetic moment except by the introduction of arbitrary parameters.

The Case for a General Theory.

Chapman and Bartels[2] (1940, vol. 2, p. 707) discuss these various theories in some detail but do not give much prominence to the particular parts of the work of Sutherland, Schuster, Wilson and Angenheister, which together establish the results already given. They sum up on the whole against a theory of the type here called a *general* theory and in favour of a *specific* theory of some type; but they do not find that any then existing specific theory is tenable. Their main reasons for the rejection of a general theory lay in the facts of the obliquity of the magnetic and rotational axes, which is 4° for the sun and 12° for the earth, and the existence of the secular variation. For the earth this means that a field amounting to some 10 per cent of the main symmetrical field would remain to be explained even if a general theory served to explain the main field. It seems to me, however, that, given a general explanation of the main field, then the convective motions, etc., that must exist in the earth's interior may well be found to modify the main field sufficiently to produce the observed field.

It is surely far more difficult to find a specific theory that will give the two striking results: (*a*) that the magnetic momenta of the sun and the earth are nearly proportional to their angular momenta—the range of variation of both being more than 10^8 to 1; and (*b*) that the constant of proportionality is nearly $G^{1/2}/c$, than it is to explain a deviation in the directions of the two axes and the existence of the secular variation.

It seems extremely unlikely that the approximate validity of equation (7) could be accidental. Its simplicity, involving as it does only the two macroscopic constants G and c, is in striking contrast to the complexity and arbitrary character of all special theories hitherto put forward, and their failure so far to provide a quantitative explanation either of the field of the earth or of the sun, far less of both.

The occurrence only of the constant $G^{1/2}/c$ multiplying the angular momentum U seems to exclude, except by way of a remarkable number of numerical accidents, the possibility that any specific properties of the rotating body, other than its size, mass and rotation, can determine its magnetic field.

If P does depend only on the macroscopic quantities M, R, ω, G, c, then dimensional considerations can be used to find the possible functional forms. Restricting our consideration to cases where P is proportional to M, we find that P can be put in the form

$$P \propto G^{1/2}c^{-1}\omega M R^2 f(\omega R/c). \quad . \quad . \quad (13)$$

For $f(\omega R/c)$ = constant, this gives our original expression (7). Since P must vary as an odd power of ω, the next likely expression is given by taking $f(\omega R/c) = (\omega R/c)^2$, giving

$$P \propto G^{1/2}c^{-3}\omega^3 M R^4. \quad . \quad . \quad . \quad (14)$$

Now our original expression gives both the observed variation of P with M, ω and R and the rough correct numerical magnitude, while the second gives neither one nor the other. It will be noticed that the second expression differs from the first by the factor $(\omega R/c) = v/c$, when v is the peripheral velocity. It is, of course, probable that at very high peripheral speeds a relativity correction involving $(v/c)^2$ would have to be introduced.

3. The Angular Momentum of a Star

As has already been explained, the approximate validity of (7) was first noted by comparing the magnetic moments of the earth and sun, assuming both to have uniform density. This, however, is far from being the case, especially for the sun, so it is necessary to take into account the central condensation of these bodies when calculating their angular momentum U.

It is convenient to introduce the ratio

$$k = I/I_0 \quad . \quad . \quad . \quad . \quad . \quad (15)$$

of the moment of inertia of a given centrally condensed sphere to that of a sphere of the same radius, angular velocity, and with a uniform density equal to the mean density of the centrally condensed sphere. Then, instead of (1), we have

$$U = \frac{2}{5}k\omega MR^2. \quad . \quad . \quad . \quad (16)$$

For the earth and major planets k is known from the work of Jeffries[21] (1924, 1937). For the sun and other stars, its value must be calculated assuming some given stellar model. First, we have the Emden polytropic gas spheres for which Eddington[22] (1926) quotes the density distributions for three values of the index n. Then there is the more recent point convective model of Cowling[23] (1935) for which new numerical calculations have been made by Blanch, Lowan, Marshak and Bethe[24] (1941) and Marshak and Blanch[25] (1946).

From their density distributions the values of k have been calculated roughly by graphical integration, leading to the figures given in Table 3, together with the ratio of the central density ρ_0 to the mean density $\bar{\rho}$.

TABLE 3. CENTRAL DENSITY ρ_0 AND RELATIVE MOMENT OF INERTIA k OF STELLAR BODIES

	$\rho_0/\bar{\rho}$	$k = I/I_0$
Uniform sphere	1·00	1·00
Polytrope $n = 2$	11·4	0·40
,, $n = 2·5$	24·1	0·28
,, $n = 3$	54·3	0·20
Point convective model	79·3	0·14
Earth	3·3	0·88
Jupiter	?	0·66

There is thus considerable uncertainty in the value of k for the sun. In what follows, we will assume the value 0·16 as the mean for the point convective model, and the polytrope with $n = 3$.

Non-uniform Rotation.

From considerations of stability it appears probable that the angular rotation of a gaseous stellar body cannot be uniform, but it is likely to increase inwards (see discussion by Milne[26], 1930, p. 241). On the other hand, it is known that the surface rotation of the sun is about 40 per cent slower at the poles than at the equator. Though so far there appears to be no certain way of estimating the magnitude of this effect, it is convenient to introduce a quantity defined by

$$\eta = U/U_c,$$

where U is the true angular momentum, and U_0 is the angular momentum calculated from the observed peripheral equatorial velocity, taking into account the variation of density but not the variation of the angular velocity. Then we know that η is of the order of, but probably rather greater than, unity.

I am indebted to Prof. Cowling for informing me that the mean period of rotation of the whole mass of the sun is very uncertain, but is probably not shorter than ten days, though it may be actually more than twenty-five days. This gives a limit of η between 2·5 and, say, 0·7.

We have therefore the following expression for the angular momentum of a rotating celestial body:

$$U = \frac{2}{5}k\eta\omega MR^2, \quad . \quad . \quad . \quad (17)$$

and so, with (2) and (7)

$$H_P = \frac{2}{5}\beta G^{1/2}k\eta\omega M/Rc, \quad . \quad . \quad . \quad (18)$$

where ω is the observed angular velocity of the surface at the equator. For a few stars the values of M and R are known accurately, but in general they have to be deduced statistically. The values of k and η can, of course, only be derived from some theoretical model of the interior of the star.

4. The Magnetic Field of a Rotating Star

4.1. *Babcock's Measurements on* 78 *Virginis*

It has long been known that many stars are rotating much faster than the sun, and so, on our hypothesis that equation (7) has general validity, should have large magnetic fields. But it is only quite recently that the magnetic field of any star except the sun has been measured. This has been achieved by H. W. Babcock[1] (1947) for 78 Virginis (spectral type $A2$), and, as has been explained in Section 1, it is satisfactory to find that within the rather large error of the measurement of the magnetic field and the statistical uncertainty of the estimation of the mass, radius and angular velocity, the results are in agreement with expectation, though the relation between the directions of the magnetic field and rotation is not known.

The rotational velocity of stars is measured by the broadening of spectral lines due to the Doppler effect of the light from different portions of the disk. A general account of the method is given by Elvey[27] (1930), Rosseland[28] (1936, p. 202) and Becker[29] (1942, p. 66). Stars of early spectral types O, B and A and early F are usually found to be in rapid rotation, with a most frequent peripheral velocity of about 100 km./sec., compared with the 2 km./sec. peripheral velocity of the sun (type $G0$). A small fraction have velocities of more than 200 km./sec. (see Table 4). The rotations seem to disappear rather suddenly between $F2$ and $F5$ types, and no observable rotations, that is, with peripheral velocities more than, say, 20 km./sec., have been observed for later spectral types. A few stars of the early types have, however, fine spectral lines, and this is interpreted as indicating that their rotational axes are parallel to the line of sight. It is only on such stars that the Zeeman effect can at present be measured.

Babcock's measurements on 78 Virginis give a polar field of 1,500 gauss. He assumes a peripheral velocity of 60 km./sec., and compares these figures with the field of 53 gauss and velocity of 2 km./sec. for the sun, concluding that the field is proportional to the peripheral velocity. This, however, lacks physical plausibility.

To test equation (7) we need M, R and ω. From tables given by Becker[29] (1942, p. 64) for the different spectral classes, we find for a star of type $A2$ that $M = 2·3$ and $R = 2·0$ in terms of values for the sun. From data on rotation given by Becker (p. 69) and reproduced in Table 4, the median peripheral velocity for A type stars appears to be about 100 km./sec. rather than the value of 60 km./sec. assumed by Babcock. The angular velocity ω must therefore be twenty-five times that of the sun, that is, nearly the same as for the earth.

TABLE 4. DISTRIBUTION OF ROTATIONAL PERIPHERAL VELOCITIES FOR STARS OF EARLY SPECTRAL TYPES, BECKER[29] (1912)

Velocity (km./sec.)	Type *O, B* (%)	Type *A* (%)	Velocity (km./sec.)	Type *O, B* (%)	Type *A* (%)
25	—	13	150	15	12
50	27	17	175	—	8
75	—	11	200	4	7
100	53	10	225	—	4
125	—	14	250	1	1

Assuming that k and η have the same values for the sun and 78 Virginis, the ratio of their polar fields, according to (11), should be proportional to $\omega M/R$, and so should have the value 29, whereas the observed value is 28. Considering the statistical nature of the data for the star shown clearly in Table 4, the closeness of the above agreement must be considered quite accidental. The direction of the magnetic field was determined, but not, of course, the direction of rotation. So no comparison of the signs of P and U is possible for this star.

4.2. *Collected Data for the Earth, Sun and 78 Virginis.*

In Table 5, we have given collected data for the three bodies. For the earth, the component along the axis of rotation of the dipole moment as given by Chapman[30] (1943) is used.

TABLE 5. RATIO P/U ALLOWING FOR CENTRAL CONDENSATION

	Magnetic moment $P=\frac{1}{2}H_PR^3$	k	Angular momentum $U=\frac{2}{5}k\omega MR^2$	$\frac{P}{U}$	$\beta=\frac{P}{U}\div\frac{G^{1/2}}{2c}$
Earth	$7{\cdot}9\times10^{25}$	0·88	$6{\cdot}22\times10^{40}$	$1{\cdot}30\times10^{-15}$	0·30
Sun	$8{\cdot}9\times10^{33}$	0·16	$1{\cdot}80\times10^{48}$	$4{\cdot}9\times10^{-15}$	1·14
78 Vir.	$2{\cdot}1\times10^{36}$	0·16	$4{\cdot}2\times10^{50}$	$5{\cdot}0\times10^{-15}$	1·16

Quite recently, one uncertainty, that of the nature and magnitude of the sun's dipole field, has been cleared up. Hale's early measurements showed a much more rapid decrease of H with height in the sun's atmosphere than would correspond to the field of a dipole. However, the work of Thiessen[31] (1946) seems finally to have established the existence of a dipole field for the sun, and gives a value for the polar field of 53 ± 12 gauss.

In the last column of Table 5 are given the values of β, calculated from (7) by inserting the observed values of P and U and taking $G^{1/2}/2c = 4{\cdot}31 \times 10^{-15}$ cm.$^{1/2}$ gm.$^{-1/2}$. It will be noticed that β is nearly unity for the sun and 78 Virginis, but about 0·3 for the earth; the latter fact had been originally noticed by Wilson[15] (1923). Alternatively, β can be obtained directly from the expression

$$\beta = \frac{5}{2} H_P Rc/k\omega MG^{1/2}. \quad . \quad . \quad . \quad (18a)$$

This equation is convenient as showing the effect on β of errors in the various quantities.

It is noteworthy that the close proportionality between P and U for the earth and sun, found on the assumption of uniform densities (Section 1), is destroyed by taking into account the central condensation of the sun and the stars.

In Table 6 the observed relative values of H_P for the three bodies are compared with the values calculated from (7), assuming that the angular momenta are calculated from equation (1) for uniform density, and equation (16) for centrally condensed spheres.

TABLE 6. OBSERVED AND CALCULATED POLAR FIELD

	H_P (observed)		Uniform density	Central condensation	
	gauss	relative	$\frac{M\omega}{R}$	k	$\frac{M\omega R}{R}$ (rel.)
Earth	0·61	1·0	1·0	1·0	1·0
Sun	53±12	86	121	0·16	20
78 Vir.	1500	2450	3500	0·16	550

4.3. *Possibility of Further Tests on Stars of the Main Sequence.*

Clearly, further measurements of the magnitude and direction of the magnetic field of highly rotating stars are of great importance to test the theory. Babcock[1] (1947) has stated that it might be possible to find the relation between the directions of H and ω on a visual binary. As shown in Table 4, some stars of the early spectral classes, rather similar to 78 Virginis, have rotational velocities about 2·5 times as high (see also Struve[32], 1930, Westgate[33], 1933, 1934). Such stars should therefore have a polar field of about 4,000 gauss.

The maximum magnetic field is set by the Roche Limit giving the maximum angular velocity ω_m for stability. This is given by

$$\omega_m = 1{\cdot}52\, G^{1/2}\,\bar{\rho}^{1/2}, \quad . \quad . \quad . \quad . \quad (19)$$

where $\bar{\rho}$ is the mean density (Jeans[34], 1928, p. 246). This suggests that angular rotations up to some four times that of 78 Virginis are possible, thus giving a maximum field for this type of star of about 6,000 gauss. If we insert ω_m from (19) in (11a), we see that the maximum possible field H_m of a star is proportional to $\bar{\rho}^{3/2} R^2$. From the variation of $\bar{\rho}$ and R with spectral type (ref. 1, p. 62), we see that H_m varies rather slowly with spectral type along the main series. Relative to the value for the sun (G0), we find $H_m = 1{\cdot}2$ for (M0) and 0·5 for (B0) type. These later types, though apparently not normally rotating fast, are capable dynamically of giving greater fields than early types.

The most satisfactory test would, of course, be on a star for which the magnitude and direction of both the magnetic field and angular velocity could be measured directly, rather than having to rely on a statistical argument for the determination of the rotation, as for 78 Virginis. It seems that this might, in principle, be done by measuring both the Zeeman effect and the Doppler effect of the light from the nearly eclipsed edge of the rear component of an eclipsing binary. But probably the experimental difficulties would be very great.

4.4. *The White Dwarfs.*

The white dwarfs should also have a large field if they are rotating with comparable angular velocities to the sun, owing to the high values of the ratio M/R on which the field depends (equation 11). The values for several white dwarfs of this ratio, which is also the ratio governing the red shift, are between twenty and thirty times that of the sun (Russell[35], 1945, p. 760), and so should give a field of about 1,300 gauss. If, however, for example, the dark companion of Sirius has the same angular velocity of rotation as Sirius itself, that is, eight days, its magnetic field would be about 5,000 gauss.

It has been suggested by Kuiper[36] (1941) that possibly white dwarfs have angular *momenta* comparable with that of the sun, as would be expected if they are formed by the collapse of such stars. Now Sirius B has nearly the same mass as the sun but only a fiftieth of its radius. If its angular momentum is equal to that of the sun, so will be, according to our hypothesis, its magnetic moment. Consequently its magnetic field will be 50^3 times as great; that is, its equatorial field will be 3×10^6 gauss.

Now the most prominent lines in the spectra of white dwarfs, and often the only lines, are the hydrogen Balmer series. These lines are, however, much broader than for normal main sequence stars. This greater breadth is generally ascribed to pressure broadening, that is, to the Stark effect due to atomic collisions, which should be exceptionally great in these stars owing to the high pressure associated with the very intense gravitational fields. It appears from the discussion by Kuiper[36] (1941) that a rough quantitative explanation on these lines is possible.

It is, however, interesting to note that a magnetic field of a few million gauss will also produce a broadening of the observed magnitude. For the double Zeeman separation of a normal triplet of the wave-length of $H\gamma$ is nearly 2×10^{-5} A./gauss, so the breadth of the Zeeman pattern should be about 60A. It must be remembered that owing to the Paschen–Back effect the Balmer lines will give nearly the normal triplet. Since the polar field is twice the equatorial field, this calculated breadth will approximately represent the double width to half intensity of the light from the star as a whole. Sirius B itself seems to have rather finer Balmer lines than 60A., and also some metallic lines. However, a number of white dwarfs, for example, 40 Eridani B and Wulf 1346 have Balmer lines of widths of about 50A. (Kuiper[36], 1941). Thus it cannot be considered unplausible to suppose that the line widths of white dwarfs are markedly greater than main sequence stars, not only because of a large Stark effect but also in part because of a large Zeeman effect. The comparison given by Kuiper of the spectra of 40 Eridani B with a comparison star shows that the line width of the latter, probably to be attributed to pressure broadening, would be enough to obscure the typical double-triplet structure of a Zeeman pattern in the white dwarf.

Many of these stars show a rather fine central core to the broad Balmer lines which is difficult to explain as due to Stark effect; and it is possible that this is caused by the undisplaced components of the Zeeman pattern, which will be the same all over the disk.

It is perhaps significant that most of the white dwarfs which are believed to be still smaller than Sirius B show no Balmer lines at all (Wulf, 489, 457, 219) or very shallow ones (AC. 70, 8247). One star, Ross 627, is anomalous in this respect, as it has rather fine lines but is nevertheless believed to be very dense.

In the spectrum of (AC. 70, 8247) there are two shallow lines more than 100 A. in breadth and centred on 4480 A. and 4140 A. If these are identified with $H\gamma$ (4341) and $H\delta$ (4102) and their breadth attributed to Zeeman effect, the required magnetic field is about 10^7 gauss. Taking Kuiper's estimate (ref. 36, p. 234) of the radius as 0·004 of that of the sun, the magnetic moment and so the angular momentum of the star relative to the sun will be $(10^7/25) \times (0{\cdot}004)^3 = 0{\cdot}024$. It is, however, possible that the observed shallow lines do not represent the whole absorption line but only the finer central core. In this case the real breadth will be considerably larger than 100 A., and so the angular momentum also will be larger—thus bringing it nearer to that of the sun.

Clearly, polarization measurements on the spectra of the white dwarfs are urgently needed, and calculations of the line profiles which would result from the combination of the Zeeman effect in large fields with pressure broadening.

I am indebted to Prof. H. H. Plaskett for pointing out that there is one white dwarf, Wolf 489 (see ref. 36, p. 211), which lends support to the explanation of the broadening by Zeeman rather than Stark effect. This star is unusual in being of a later colour type ($G8$) and so should show strong lines of ionized calcium. In fact, it shows no lines at all. Since Ca$^+$ lines are very much less influenced by the Stark effect than hydrogen lines, it is difficult to explain their absence as due to the Stark effect. Thus the Zeeman effect, to which the H and Ca$^+$ lines are equally sensitive, provides a more plausible explanation.

Since the Zeeman breadth $\Delta \lambda_Z$ is proportional to the surface magnetic field and so, according to (2) and (7), to U/R^3, while the Doppler breadth $\Delta \lambda_D$ is proportional to the peripheral velocity and so to $U/M.R$, the ratio $\Delta \lambda_Z/\Delta \lambda_D$ is proportional to M/R^2 and so is independent of the rotation. For very small and dense stars the Zeeman breadth becomes greater than the Doppler breadth. For Sirius B, $\Delta \lambda_Z$ is about twenty times $\Delta \lambda_D$. The two breadths will be equal for a star of about the sun's mass, which has a radius about five times that of Sirius B. The period of rotation of Sirius B, if it has the same angular momentum as the sun, is fifteen minutes, and its peripheral velocity 100 km./sec. Owing to the high density, the limiting period set by the Roche limit is about forty seconds.

4.5. *The Major Planets.*

Another interesting possibility is that Jupiter might have a measurable field. Take the value of k as 0·66, as given by Jeffries[21], with $R = 7{\cdot}0 \times 10^9$ cm., $\bar{\rho} = 1{\cdot}35$, $T = 9{\cdot}8$ hours, we find from (18a) that the polar field is about 30 gauss, using the value of β for the earth, and 120 gauss with the value for the sun. Probably such a small field would be unmeasurable, as the only spectral lines available are apparently the absorption bands of methane and ammonia; the low temperature 150° abs. would, however, help by making the lines narrow.

5. Theoretical Discussion

5.1. As has already been explained, early attempts to explain the magnetic field of the earth on the lines of a general theory tentatively assumed that the earth was in some way electrically charged. Since the earth has a very small external electric field, it was necessary to assume that the net charge was zero, and so a separation of positive and negative charges within the earth was postulated. To explain the sign of the magnetic field, it was necessary to suppose that the negative distribution was displaced outwards. A special case of such a distribution (Sutherland[14], 1904) is that of a uniform positive volume charge combined with negative surface charge of equal total magnitude.

A charge separation theory of this type has the great merit of explaining very simply the existence of a magnetic field due to a rotating body, and the absence of a magnetic field due to pure translational motion. Provided, however, that the normal laws of electro-magnetism are assumed, it is quite impossible to believe in the existence of a real charge-separation of the required magnitude. This is given by (12), and for the earth is of the order of 10^{-3} E.S.U., or 10^6 electrons per unit volume. But such a charge distribution implies an electric field inside the earth of the order of 10^8 volts/cm., which is greater than the dielectric strength of any known material. In the sun its non-existence is still more obvious. Since the conductivity both of the central core of the earth and of the ionized matter in the sun are relatively high, any such charges which were produced by any static E.M.F. would very rapidly be conducted away. Chapman[37] (1928) and Cowling[6] (1945) have calculated that the conductivity of the matter at the sun's centre is of the same order as that of copper at normal temperature.

Actually there will, of course, be some separation of positive and negative charges in an ionized gas in a gravitational field, due to the large difference in mass between the electrons and the positive ions. Pannekoek[38] (1922) and Rosseland[39] (1924) have treated this question (see ref. 22, 1926) and have proved from the Maxwell–Boltzmann equation that a charge density of magnitude

$$\sigma_e = G\rho\mu/e, \quad . \quad . \quad . \quad . \qquad (20)$$

when μ is the mass of the positive ions and e is the electronic charge, will be produced by the tendency of the electrons to move to regions of higher gravitational potential.

For the sun, the mean molecular weight is about 2·2 in terms of the hydrogen atom. Comparing (20) with (12), we see that the ratio of the charge density and so the electric field, due to this separation of electrons and ions in the gravitation field, to the charge density and electric field necessary to explain the magnetic field of the earth, is about 10^{-17}. Essentially the same result was obtained earlier by Brunt[4] (1913) in a less general form. The sign of the charge distribution is the same as that required to explain the magnetic field, that is, the negative charge is outermost.

Cowling[40] (1929) has pointed out that when an ionized medium in a gravitational field is moving at right angles to a magnetic field, then the electric field due to the separation of the charges is considerably greater than that given by (20). It is still, however, far too small to explain the observed magnetic moments.

If the normal electro-magnetic equations are assumed valid, it is clear that no adequate real charge separation can exist. Thus some alteration in the fundamental equations seems inevitable. Further, it is difficult to believe that any possible alteration of the electro-dynamical equation can allow the existence of a real charge density in the earth and sun of the required magnitude. Still, it is possible that the charge separation theories of Schuster, Schlomka and others, which depend on the hypothesis of lack of exact equality between protons and electrons, etc., may repay further study.

Another type of alteration of the electro-magnetic equation is that proposed by H. A. Wilson, who postulated that a mass in moving with velocity v, even though electrically neutral, produces a magnetic field given by (8).

This hypothesis, however, is certainly untrue, if v is interpreted as a relative translational velocity. For example, an observer in an aircraft moving at 500 km./hr. relative to the earth can be considered as at rest with the earth moving past him at the same velocity. Thus, according to (8), he should observe a magnetic field of the order of 1 gauss and with a direction quite different from the actual field of the earth. Again Wilson disproved this relation by a laboratory experiment.

There is also, of course, a theoretical objection to the existence of any magnetic field associated with the translational motion of a neutral mass. For the normal Lorentz transformations for free space show that the magnetic field given by (8) can only exist if the assumed 'neutral' mass has an electric charge $Q \sim G^{1/2}m$; this contradicts the assumption that the mass is uncharged.

We must conclude, therefore, that a neutral mass with a pure translational velocity does not produce a magnetic field according to (8). However, for the purpose of explaining equation (7), it may not be necessary to assume that (8) is true for pure translational motion. If, for example, the velocity of a mass element δm is interpreted as that velocity relative to an observer which is produced by the absolute rotation of the body, then one can use (8) to explain (7) without necessarily concluding that a neutral mass in pure translational motion produces a magnetic field. We conclude, therefore, that equation (8), with an additional multiplying factor β, may possibly provide a tentative explanation of (7), provided v is defined as the relative velocity due to rotation as measured with reference to the inertial frame of the universe, that is, by the equation $v = [\omega.R]$, when ω is the measured absolute rotation and R the radius vector from the centre of gravity.

It is not, however, clear to me whether it is, in fact, possible to retain (8) for rotational motion and deny it for translational motion without some far-reaching alteration in the electro-magnetic and dynamical equations. No difficulty occurs in the application to a single rigid rotating body, but how to avoid difficulties in connexion with the orbital motion of, say, the planets or a double star is not so clear. As has already been pointed out, this difficulty does not occur on the hypothesis of a real charge separation. For here we have two equations of type (9), one with Q and H positive and one with them negative. It is the cancellation of the magnetic fields from the opposite charges which give a magnetic field for rotational but not for translational motion. The problem is whether one can obtain the same result with the single equation (8). If this proves impossible, then one may be forced back on some theory equivalent to the assumption of virtual electric charges, that is, charges which produce a magnetic field but not an electric field. A hint of how this might be done may possibly be obtained from considering the field of the neutron.

At the time of the first attempt to explain the magnetic field of the earth, no magnetic fields were known except those associated with a movement of electric charges or with a time variation of electric intensity. This is no longer the case, since it is now known that the neutron has a magnetic moment. This amounts to 1·80 Bohr nuclear magnetons, and the magnetic moment and spin vectors (angular momentum) are opposite in direction, as they are for the earth or sun. In some current meson-field theories, the difference between the magnetic moments of the neutron and proton are attributed to the existence of virtual mesons, thus bringing in virtual but not real electric charges. Possibly this might be taken as a hint that the magnetic field of a massive rotating body might be attributed to such a virtual charge separation. The observed linear variation of H with ω shows that such a virtual charge separation cannot be the result of the rotation but must be a property of a massive body at rest.

Since the ratio P/U for a neutron is about 10^{-3} of that for a Bohr atomic magneton, it can be seen from (6) that there is no obvious numerical relationship between P/U for a massive body and P/U for a neutron, unless one quite arbitrarily introduces such a non-dimensional ratio as $e^2/hc = 1{\cdot}16 \times 10^{-3}$.

It seems at present impossible to find an explanation of the fact that $\beta \cong 0{\cdot}3$ for the earth and about unity for the sun and 78 Virginis. The screening effect of ferromagnetic materials in the earth's crust could not possibly give an effect so large as 1 per cent. It is, of course, possible that the fault lies with the values of k and η assumed for the sun and 78 Virginis. If the products $k\eta$ were in reality three times as large as assumed, the discrepancy would be removed. But so also would be the attractive feature that β is nearly unity for the sun and 78 Virginis.

An alternative possibility is that the difference is due to some small effect of the *specific* properties of terrestrial or stellar matter, superimposed on the *general* mechanism responsible for the existence and order of magnitude of the main field. One might, perhaps, attribute the difference of the value of β to, say, the proportion of free electrons in the matter, or to the ratio of protons to neutrons.

Clearly the experimental result (7) and its hypothetical explanation (8) are to be considered as holding only for the non-relativistic case. When peripheral velocities comparable with c occur, modifications are clearly to be expected.

In general, it seems very probable that a satisfactory explanation of equation (7) will not be found except within the structure of a unified field theory. In this connexion equation (6) may be of special significance in view of the important part that the non-dimensional rate $G^{1/2}m/e$ must play in any such theory.

5.2. *The Magnetic Field of an Asymmetric Body.*

We have implicitly assumed so far that the static magnetic field given by (7) for a sphere must ultimately be expressible as an integral over all parts of the body. Though equation (8) represents one differential form which gives the observed result for a sphere, apart from the numerical factor β, we must inquire if there are likely to be solutions of a different type. For the following reasons this seems unlikely. First, the fact that, for a sphere, H is found experimentally to vary as ρ (see equation (11a)), implies that H must be expressible as the vector sum of contributions δH from each mass element considered separately. For if, for example, δH for a mass element depended not only on δm, but, say, also on the gravitational potential at the element, then H for the whole body would not be a linear function of ρ. If, therefore, we assume that each mass element gives an independent contribution to the total field, then (8) appears the only form which will give the observed linear dependence of H on ω.

It is possible, of course, that the correct solution is of the form of (9) rather than (8), where δQ is interpreted as some form of virtual charge taking both positive and negative values. If this is so, then δQ for any volume element may depend on the whole configuration of the body, as it would for a real charge separation, and not only on δm.

Until this question is settled, it is not possible to calculate the magnetic field of an asymmetric body, such as a massive ellipsoid rotating, say, about its shortest axis. This is of importance in connexion with possible laboratory experiments, as it might prove technically easier to measure the alternating field which one would expect from such an asymmetrical body, rather than the static field of a symmetrical one.

The general question then arises as to whether one can, in fact, extrapolate (7) and (8) to the laboratory scale. Though (7) holds experimentally roughly over a range of U of more than $10^{10}:1$ for the three astronomical bodies, does this justify the necessary extrapolation of $10^{28}:1$ from the earth to the case, say, of a bronze sphere of 1 metre diameter rotating at 100 r.p.s., which should give a field of about 10^{-8} gauss (see next section).

The physical conditions of the material of such a laboratory sphere differ so widely from that of the earth, not only in respect of size, but also of temperature, pressure and tension, ratio of gravitational to centrifugal forces, etc., that little can be concluded until a consistent theory of (7) has been found.

It may be noted that the separate ranges of R, ω and ρ for the three astronomical bodies are about $220:1$, $25:1$, and $14:1$, respectively. The extrapolation to a laboratory sphere involves an extrapolation of $1:10^{-7}$ for R, and $1:10^{7}$ for ω.

5.3. *Possibility of Laboratory Test.*

Assuming that the extrapolation is justified, we can calculate the maximum field from a sphere of given material. Giving β the value 0·30 as for the earth, the polar field of a rotating sphere is found from (11a) to be—

$$H_P = 1{\cdot}07 \times 10^{-15}\rho\omega R^2. \quad . \quad . \quad (20)$$

In this expression we have to insert the maximum possible value ωm rad./sec. consistent with the maximum safe tensile stress S gm./cm.^{2}; using for this the value for a disk given by Svedberg (1940), which can be put in the form

$$\omega m = 50\, S^{1/2}\rho^{-1/2}R^{-1}, \quad . \quad . \quad (21)$$

we find

$$H_P = 5{\cdot}4 \times 10^{-14}S^{1/2}\rho^{1/2}R. \quad . \quad . \quad (22)$$

We thus see that $H_P \propto R$, hence the advantage of a large body rotating correspondingly slowly. Taking $\rho = 8$, and, for example, $S = 3{\cdot}0 \times 10^6$ gm./cm.^{2} or 43,000 lb./sq. in., we find:

$$H_P = 2{\cdot}6 \times 10^{-10}R. \quad . \quad . \quad . \quad (23)$$

For a 1-metre sphere ($R = 50$ cm.), the maximum speed is 100 r.p.s. and $H_P = 1{\cdot}3 \times 10^{-8}$ gauss. For a 10-metre sphere, the speed is only 10 per sec. and the field is $1{\cdot}3 \times 10^{-7}$ gauss. If it should turn out that the correct value of β to take is that for the sun rather than that for the earth, these fields would be multiplied by three.

If an asymmetrical body of the same maximum linear dimensions were used, then one would obtain a smaller field than that given by a sphere; but the fact that it would be alternating might permit detection of this smaller field more easily than is possible for the static case.

The only experiment which appears to have been carried out to attempt to detect the magnetic field of a rotating body is that of Swann and Longacre[20] (1928), who spun a copper sphere of 10-cm. radius at 200 r.p.s. According to (20) the field should be about 10^{-9} gauss. The experimental method was only sensitive enough to show that no field so large as 10^{-4} gauss was produced.

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BRITISH ECLIPSE EXPEDITION TO BRAZIL

IN consequence of the aeroplane disaster at Dakar in the early hours of April 13, the British expedition to observe the total eclipse of the sun of May 20 at Araxa in Brazil has been cancelled.

The programme approved by the Joint Permanent Eclipse Committee of the Royal Society and the Royal Astronomical Society comprised four items.

The profiles of the chromospheric lines were to be observed using a Michelson echelon grating. The apparatus devised provides for a succession of short exposures at several points of the sun's limb to study the variation of profile and intensity with height above the sun as the moon successively masks off the lower layers. Some indication was hoped for of transition from photospheric temperatures to the high excitation temperatures now attributed to the coronal regions.

The corona was to be photographed in its own green monochromatic radiation through a large aperture (13·5-cm.) Fabry–Perot étalon to gain information on internal motions or rotation and to determine the profile of the green line accurately, also with a view to temperature assessment. The plates of the étalon had a separation of just over 1 mm. and were aluminized to give a resolving power of some 400,000. The coronal image would be crossed by arcs of circular fringes the displacement or distortion of which would reveal the motions. These two instruments were designed by Dr. J. A. Carroll, now deputy for research and development to Controller of the Navy and scientific adviser to the Board of Admiralty, during his occupancy of the chair of natural philosophy at Aberdeen.

In addition, it was planned to determine the darkening towards the limb by using one of the infra-red photo-cells, developed at the Admiralty Research Laboratory, with suitable recording gear.

Observations to measure solar radio noise at a frequency of about 60 megacycles/sec. were also planned with the collaboration of the War Office and Ministry of Supply, apparatus having been prepared by Dr. J. S. Hey and Major S. J. Parsons.

Dr. Carroll had been asked to take charge of the expedition, its organisation and preparation by the Joint Permanent Eclipse Committee, assisted by Dr. A. Hunter from the Royal Observatory, Greenwich, and one or two others, depending on what could be organised in the time available. During the period of preparation, he succeeded Mr. A. P. Rowe in the chief scientific post at the Admiralty, and it was impracticable for him to give the time required for preparation of, and participation in, the expedition as originally contemplated. The specialized nature of the equipment made assistance hard to find. Dr. Alan Baxter, who had been on Prof. Carroll's staff in Aberdeen, was familiar with it and had participated substantially in its design and development there for use in Omsk in 1936, but he had become a principal scientific officer in the Royal Naval Scientific Service. The Board of Admiralty took the view that, in the circumstances, it was reasonable that they should advance pure scientific research by making their scientific officers' services available to the expedition. The remaining expert optical member required for the team was Mr. J. H. Strong, of the Spectroscopy and Astrophysics Department of the Imperial College of Science and Technology.

During the last few months of 1946 and the first three of 1947, the equipment was assembled, modified and tested by this team in a room made available at the Admiralty Research Laboratory and with assistance from the Laboratory's workshops. The intention was that the gear and three observers, Dr. Baxter, Dr. Hunter and Mr. Strong, should proceed by sea in time to give them a clear month on the site, they being joined about ten days before the eclipse day by Dr. Carroll and Major Parsons. Various factors, among them the fuel crisis in Britain, caused the last ship which could be relied upon to reach Rio de Janeiro in time to be one due to sail on March 11. This was only known a few days beforehand, and it was barely possible to complete testing, dismantle all instruments, pack them and get them on board, particularly as the fuel cuts and the weather had seriously slowed up the later stages of the work. However, the gear, with the exception of the Fabry–Perot étalon and certain parts of an image rotator used in the echelon spectrograph, was dispatched, and arrangements made for the three observers to go out by air a month later. In attempting landing at Dakar while the airfield there was fog-bound, the aeroplane carrying the observers broke up, Dr. Baxter being killed instantaneously, Mr. Strong receiving injuries which at first were thought not dangerous but later proved fatal (see p. 667). Dr. Hunter escaped with severe cuts and abrasions. An emergency party was tentatively arranged to fly out and carry on if the apparatus with Dr. Baxter was intact, but on word being received that the étalon plates were smashed and the image rotator parts missing, it was clear that the optical observations must be abandoned; and since the radio observer was dependent on assistance and facilities to be provided from the rest of the expedition, that part of the programme had to be abandoned too.

OBITUARIES

Dr. Alan Baxter and Mr. John H. Strong

The aeroplane disaster at Dakar on April 13 cost the lives of two young men of science, who were to take part in the observations of the total solar eclipse on May 20 (see p. 666).

In Dr. Baxter, the Royal Naval Scientific Service has lost one of its most valuable younger members. Born in 1910, he was educated at Manchester Central High School and the University of Manchester. He graduated with honours in mathematics and in physics, proceeded to research in microphotometry and X-rays under Prof. (now Sir Lawrence) Bragg, taking his M.Sc. in 1932 and a Ph.D. in 1935. In 1934 he joined the staff of the Natural Philosophy Department of the University of Aberdeen, later becoming a lecturer in physics. He had a conspicuous talent for perceiving the critical features of an experiment or proposed design of apparatus and a genius for simple investigation of essentials. This made him a very valuable member of the Admiralty scientific staff during the War. At Aberdeen he became interested in physical optics and astrophysics and carried out at a temporary observatory just outside the city of Aberdeen during the winters of 1937 and 1938 continuous spectrophotometric observations of the variable star Algol. The analysis of the results strongly suggested a more complex structure for Algol than a binary system; the advent of war prevented complete working out and publication of the results.

Baxter returned to Aberdeen for a time after the War, but found the Naval Scientific Service attractive to him and entered it as a permanent officer in 1946. He married in 1937 and is survived by his wife and two young daughters. He was a very welcome colleague, liked and respected, and his premature loss is deeply regretted.

Mr. John Strong was born in 1924 and educated at the Latymer Upper School and the Imperial College of Science and Technology, South Kensington. He graduated with honours in physics in 1944 and was appointed a demonstrator in the Spectroscopy and Astrophysics Department under Prof. H. Dingle and Sir George Thomson. He was carrying out research on a new type of arc source for spectroscopic analysis and was measuring the temperatures of various regions of the arc by means of the cyanogen bands. He was interested in interferometry and in astrophysics, and the eclipse observations offered excellent experience in his chosen field of research, which fitted him to be a valuable member of the observing team; and the Imperial College gladly agreed to make his services available. He was keen, energetic, eager and quick to learn.

It is particularly regrettable that what should have been valuable experience for these young men, from both of whom substantial contributions to science could confidently be expected, should have ended so tragically.

J. A. Carroll

Mr. W. J. Bean, M.V.O., I.S.O.

It is with deep regret that we have to record the death of William Jackson Bean, formerly curator of the Royal Botanic Gardens, Kew, who was known to every cultivator of hardy trees and shrubs by his standard three-volume work, "Trees and Shrubs Hardy in the British Isles". His death occurred on April 19 after a rather protracted illness, when within a few weeks of his eighty-fourth year. Born on May 26, 1863, in a village at the foot of the Yorkshire Wold, near Malton, his love for plant life was inherited, as for three generations his forbears had functioned as nurserymen. He was educated at Holgate School, York, and at the age of sixteen entered the famous gardens at Belvoir Castle to receive his early training in horticulture. At twenty years of age he entered the Royal Botanic Gardens, Kew, as a student gardener, and was quickly earmarked for promotion. After serving as sub-foreman in the Palm House and Orchid Houses, he was appointed foreman of the Temperate House, a position he occupied for several years before being transferred to the Arboretum as foreman in 1892.

During all this time and for several succeeding years, Bean contributed many articles to the horticultural press, chiefly *The Garden* and *The Gardeners' Chronicle*, while in 1890 he collaborated with the late William Watson in the writing of a book on "Orchids, Their Culture and Management". He was appointed assistant curator at Kew in 1900, with special charge of the Arboretum and Arboretum Herbarium. During the next few years he was sent abroad on various missions connected with arboriculture, chiefly to the United States of America and countries of Southern Europe.

At the instance of the late Sir William T. Thiselton-Dyer, Bean was entrusted with the preparation of a book descriptive of the Royal Botanic Gardens, Kew, and the work done there, which was published in 1908. It was in 1908 that he began serious work on the first two volumes of his great book on trees and shrubs, which took several years to complete; the third volume was prepared after his retirement. He also contributed many articles to the *Kew Bulletin of Miscellaneous Information*, mostly descriptive of his several journeys abroad and on new trees and shrubs. He was also a member of the committee appointed by King George V to advise on the trees in Windsor Great Park; was a member of the Floral Committee of the Royal Horticultural Society, and helped with the work of the Roads Beautifying Association from its inception.

Many honours came his way. In 1918 he was awarded the Victoria Medal of Honour by the Royal Horticultural Society, and in 1923 the same Society awarded him the Veitch Memorial Medal; later he was made an honorary member of the Society. In 1925, Bean was made a companion of the Imperial Service Order, and a few years later he received the membership of the Victorian Order for his work connected with the trees at Windsor. When Mr. Ernest Moore, the artist, was preparing for his exhibition of portraits of famous Yorkshiremen, Bean was selected as one of the number. The portrait was later purchased by Major Reginald Loder and presented to Kew. Bean retired in 1929, since when he lived in Kew within a stone's throw of his old office, spending a good deal of time in the Gardens and Herbarium, mostly at work. In his early days he found his recreation in cricket; later he played both lawn-tennis and golf.

Personally, I feel the loss of Mr. Bean very greatly. We were associated in one capacity or another for nearly forty years. For several years I was his subordinate in the Arboretum and succeeded him as foreman. I was then transferred to the museums where we had adjoining offices, he as assistant curator, I as an assistant in the museums. Later he became curator and I keeper of museums, positions which brought us into daily contact; and throughout the whole of the time we spent together never a disagreeable word passed between us. I last saw him in September 1946, when he was far from well. He had been a widower for many years and leaves one son and one daughter, to whom our sympathy is extended.

W. DALLIMORE

Prof. B. A. McSwiney, F.R.S.

MAY I please supplement the obituary notice in *Nature* of May 3 as follows: McSwiney, a Cork man, entered Trinity College, Dublin, in 1912, and I first met him when assigned to my section of a practical class for first-year medical students. He joined the O.T.C. and in September 1915 was commissioned as a Surgeon Sub-Lieutenant R.N.V.R., and served in H.M.S. *Staunch*. He graduated in 1916 and afterwards completed his medical course and received the Sc.D. degree. In anatomy and physiology we were both grateful pupils of Prof. A. F. Dixon and Sir William Thompson. The latter was drowned when the *Leinster* was sunk in 1918. He was on his way back to his post as scientific adviser to the Ministry of Food in London. Thompson was a pioneer in the study of nutrition; he and his assistant, Dr. Caldwell, fed themselves on a rigid diet for weeks on end, performed all necessary analyses and then varied the diet and noted the changes—this asceticism on top of arduous teaching work.

W. R. G. ATKINS

WE regret to announce the following deaths:

M. Edouard Chatton, formerly professor of zoology in the University of Montpellier, *Correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences, on April 23.

Prof. P. L. R. Lespieau, titular member of the Section of Chemistry of the Paris Academy of Sciences, on April 21, aged eighty-two years.

Mr. G. H. Tipper, formerly of the Geological Survey of India, on April 23.

Commander H. D. Warburg, formerly superintendent of tides, Admiralty, on May 7, aged seventy-eight.

NEWS and VIEWS

Royal Society: New Foreign Members

Prof. P. Karrer

PAUL KARRER, professor of chemistry in the University of Zurich, is one of the world's leading organic chemists. A pupil of Ehrlich, his work, beginning on chemotherapeutic problems, has since ranged over a wide field of organic chemistry. In particular he has achieved outstanding success in the study of substances of biological importance, notably in the vitamin field, and his work has played a large part in the spectacular successes of organic chemistry during the last twenty years. Karrer's work on the carotenoid pigments and the structural elucidation of vitamin A has been the basis of our present knowledge of the group, and mention may also be made of his constitutional work on the structure and synthesis of vitamin B_2 (riboflavin) and the vitamins E. Notable contributions, too, have been made by him to the chemistry of plant colouring matters of the anthocyanin type, and to our knowledge of the nature and mode of action of various co-enzymes. His laboratories have for long been a centre of attraction for workers from many countries. The brilliance of his achievements was recognized in 1937 by the award of a Nobel Prize. In addition to furthering chemistry by his research, Karrer has made a notable contribution to teaching through his text-book of organic chemistry, which enjoys a world-wide reputation.

Prof. H. C. Urey

PROF. H. C. UREY is known internationally for his great contributions to physical chemistry, and for his human approach to the problems of the social implications of science. His discovery of deuterium (heavy hydrogen) in water was recognized by the award of a Nobel Prize; but most important of all, this work established his interest in the problem of isotope separation. His development of chemical exchange, distillation and other methods of separation of isotopes has enabled American firms to market such materials as N^{15} as commercial commodities. Urey was one of the first in the United States to recognize that atomic weapons could be made, and his influence was crucial in the early history of the American project. He was identified closely with development at Columbia University of the diffusion process for separation of the uranium isotopes, and he visited Great Britain in this connexion at the height of the War. The menace to civilization presented by the discovery of atomic explosives was a challenge to Urey's social conscience, and after the War he devoted himself wholeheartedly to the public dissemination of information designed to impress the problem on the people of America and the rest of the world. Since the War ended, Urey has joined the new Institute which has been established in the University of Chicago to carry out academic researches in nuclear physics.

Prof. Øjvind Winge

PROF. ØJVIND WINGE has a record of extraordinary versatility and success in genetics and cytogenetics. In his early work with the fish *Lebistes reticulatus* he established the partial sex-linkage of a large group of genes determining the male polymorphism of the species. This was the first demonstration of the genetic activity of the pairing segment of the sex chromosome. Later he established genetic sex-determination in plants, and elucidated the nature of polyploidy. One remarkable success based on keen observation and appropriate experimentation was to demonstrate the balanced lethal situation established in the 'ever-sporting Stocks'. He has contributed much to the clarification of linkage groups in *Pisum*, and his recent work proving sexual reproduction in the yeasts is of fundamental importance for the genetics of micro-organisms.

James Alfred Ewing Medal Awarded to Sir Clifford Paterson, O.B.E., F.R.S.

On the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1946 to Sir Clifford Paterson, for specially meritorious contributions to the science of engineering in the field of research. The medal is awarded annually and was founded in 1936 in memory of Sir Alfred Ewing. Sir Clifford Paterson is in charge of the Research Laboratory of the General Electric Co., Ltd., Wembley, Middlesex. His contributions to the science of engineering in the field of research have extended over forty-five years. His work has been particularly outstanding in the development of new sources of illumination, in the study of their use and in their precision measurement. This work was carried out at the National Physical Laboratory until 1919 and later continued after he had joined the General Electric Co. More recently he has co-ordinated the work of numerous teams in connexion with outstanding developments in the use of high radio frequencies, thus making possible many of the vital new weapons of defence and offence. The production of special devices and particularly of new valves in quantity, at many stages of the War, kept our Services ahead of those of the enemy.

Royal Aeronautical Society Awards

The following medals have been awarded by the Council of the Royal Aeronautical Society:

Simms Gold Medal: awarded annually for the best paper read in any year before the Society on any science allied to aeronautics, such as meteorology, wireless telegraphy, instruments, to Prof. L. Aitchison, professor of industrial metallurgy, University of Birmingham;

George Taylor (of Australia) Gold Medal: awarded annually, at the discretion of the Council, for the most valuable paper submitted or read during the previous session, to Prof. A. R. Collar, Sir George White professor of aeronautical engineering, University of Bristol;

Wakefield Gold Medal: awarded annually to a member or non-member, to the designer of any invention or apparatus tending towards safety in flying, to Mr. Edwin Link, inventor of the 'Link trainer';

Society's Silver Medal: awarded, at the discretion of the Council, for an advance in aeronautical design, to Mr. W. G. Garter, chief designer, Gloster Aircraft Co., Ltd., for his work on the development and design of jet-propelled aircraft.

*R.*38 *Memorial Prize:* offered annually for the best paper received by the Society on some subject of a technical nature in the science of aeronautics, preference being given to papers which relate to airships, to Mr. J. K. Hardy, of the Royal Aircraft Establishment;

Edward Busk Memorial Prize: offered annually for the best paper received by the Society on some subject of a technical nature in connexion with aeroplanes (including seaplanes), to Mr. J. Smith, chief designer, Vickers Armstrongs, Ltd., Supermarine Works.

University of Glasgow: Freshwater Biological Laboratory and Insect Field Station

Important additions to the facilities available at the University of Glasgow for research and teaching in the field have recently been made available by the erection of two former Government huts on the shores of Loch Lomond, on a site kindly provided by Sir Iain Colquhoun, Bt., of Luss, and only some twenty miles distant from the University. The freshwater work is under the care of Dr. H. D. Slack, lecturer in freshwater biology, who has charge of one hut together with a motor-boat and dinghy. For the first time, continuous investigations can be carried out on the biology of freshwaters in Scotland, and the great size and exceptional depth of Loch Lomond render it an admirable site for such work. A generous gift of money by Sir Harold Bowden, Bt., for entomological research over a period of seven years, with particular reference to the biology of midges, is responsible for the erection and equipment of the second hut, and for the appointment of two research assistants who work under the direction of Mr. J. A. Downes, lecturer in entomology. The money is being shared with the Department of Natural History, University College, Dundee (University of St. Andrews), where the biology of *Monomorium* together with certain aspects of the midge problem are being studied by Prof. A. D. Peacock and assistants. This opportunity of co-operation between two Universities is particularly appreciated. The work of both centres is being co-ordinated with that of the Committee on the Control of Midges appointed by the Department of Health for Scotland. The Insect Field Station is also being used as a centre for the teaching of insect ecology. The University of Glasgow is thus in the fortunate position of being able to conduct field classes in freshwater biology and in insect ecology at Loch Lomond, and also to avail itself of the rapidly increasing facilities for marine biology available at the Millport Laboratory of the Scottish Marine Biological Association on the Clyde.

Further Education

It is the custom to greet a new magazine by asserting, often with more courtesy than truth, that it will fulfil a long-felt need. No such formula need apply to *Further Education*, published by the Turnstile Press, 10 Great Turnstile, London, W.C.1 (1*s*. 6*d*. monthly). The field which it covers is only beginning to be opened up, for a recognition of the need for further education too seldom troubled the education administrators of the last generation. The War did much to disclose the need and (what was more unexpected) did something to give it satisfaction. Many thousands of men and women in the Forces made their first acquaintance with 'serious pleasures', and have returned to civil life seeking the extension of that experience. The Education Act of 1944 envisaged a wide post-war enlargement of educational activity, and in its recent pamphlet, "Further Education", the Ministry set forth for the benefit of local education authorities many ideas and projects worthy of experiment and development. By March 31, 1948, local education authorities are obliged, with minor exceptions, to submit their schemes of further education to the Ministry. Many of them have already begun, and even the backward authorities will have something to promise, if not to display, by the appointed day.

Further education may henceforth hope to enjoy something better than the status of a lesser mandated territory. But a sentimental ardour for its benefits is not enough. What are especially required during these next few years are practicable schemes, reliable progress reports, and a brisk exchange of ideas. The first number of *Further Education* reveals a realistic purpose in providing these requirements, and is not afflicted by that sense of piety which so often besets ventures which want to advance human progress. In writing or talking about further education it is better to be hard-boiled than half-baked, and one of the characteristics of this new magazine is its preoccupation with ways and means. Its editor, Mr. J. Mackay Mure, is a fervent educationist, and his management of the paper's policy is an assurance that it will keep both feet on the ground. From the first number, it is plain that he intends to take full advantage of the terms of reference embodied in the paper's title. Further education has as much to do with vocational training as with the pursuit of culture, and the more we can be led to considering them as part of a common way of life the sooner shall we discern their relevance to each other. One final merit of this new monthly must be mentioned, and that is the lively quality of most of its articles. Nowhere has the boll-weevil of jargon made greater ravages than in educational journalism, and it is a welcome relief to find it entirely absent from these pages.

The Ray Society

THE annual general meeting of the Ray Society, now in its hundred and third year, was held on March 21. During the past year the Society lost by retirement owing to ill-health the services of its two senior officers, Sir Sidney Harmer, president since 1931, and Dr. W. T. Calman, secretary since 1919. Resolutions were passed unanimously thanking them for their distinguished services to the Society. Prof. F. E. Weiss having expressed the wish to retire from the office of honorary treasurer, his resignation was accepted with regret. Mr. A. D. Cotton resigned as vice-president. It was announced that Dr. Ben Dawes' volume on "The Trematoda of British Fishes" is ready for distribution, and, owing to the greatly increased costs of publication, this will form the issue to subscribers for the two years 1944 and 1945. The volume for 1946 will be Dr. Berrill's volume on "British Tunicates", but unexpected difficulties have caused delay in sending this work to press. A volume on Pennant's travels in Europe, edited by Prof. G. R. de Beer, is, however, nearly ready for press, and other works on a wide variety of subjects relating to the natural history of the British Isles are in active preparation. The following were elected officers and new members of council: *President*, Prof. G. R. de Beer; *Hon. Treasurer*, Mr. A. C. Townsend; *Hon. Secretary*, Dr. Errol I. White; *Vice-presidents*, Prof. F. E. Weiss, Mr. M. A. C. Hinton, Mr. E. R. Martin and Lieut.-Colonel Seymour Sewell; *Members of Council*, Mr. A. H. G. Alston, Dr. J. W. Evans, Mr. H. R. Hewer, Dr. George Taylor and Mr. Brian Vesey-Fitzgerald.

New British Ornithological Magazine

THE first issue of the new *Wild Birds Magazine* has appeared as a bi-monthly (until the paper ration increases) under the editorship of Mr. Eric Hardy and published from Friars Lodge, Friars Lane, Richmond, Surrey. There are illustrated articles dealing with bird-life at Manchester sewage farm (L. L. Turner), observations at the Yorkshire Naturalists' Union's new bird ringing and observation station at the Spurn by J. Lord, on a heronry (F. A. Lowe), birds of North Devon (N. V. Allen), Dungeness shingle (R. B. Burrowes), etc., while field notes include the first Lancashire record of the European bee-eater (*Merops apiaster*) in the autumn 1946, and the red-backed shrike using the same nesting site in two successive years. An abnormal immigration of waxwings and great grey shrikes into England during the recent winter is noted.

Industrial Uses of Methane

A PAMPHLET entitled "Chemicals from Methane", by Dr. J. P. Lawrie (pp. 24. Science Services, Ltd., 255 Russell Court, London, W.C.1, 1947. 3*s*.), deals with possible uses of methane from natural gas which, it is said, is available in important quantities in Great Britain. It is pointed out that large quantities of carbon black are imported from the United States, much of which is made there from natural gas, and it is suggested that this might well be made from native gas. Coke-oven gas is also rich in methane. Other products which might be obtained from methane, according to patent literature quoted, are hydrogen for ammonia synthesis, acetylene by exposure to an electric arc, methyl chloride by chlorination, hydrogen sulphide by reaction with sulphur, oxidation products such as methanol, formaldehyde, and formic acid, and nitromethane. A short bibliography is given.

Royal Institution

AT the anniversary meeting of the members of the Royal Institution held on May 1, the following officers were elected: *President*, Lord Rayleigh; *Secretary*, Prof. A. O. Rankine; *Treasurer*, Dr. R. E. Slade; *Managers*, Prof. E. N. da C. Andrade, Mr. M. G. Bennett, Prof. H. V. A. Briscoe, Major W. H. Cadman, Sir John Craig, Dr. C. H. Desch, Sir Alfred Egerton, Dr. E. V. Evans, Dr. W. Jevons, Colonel E. E. B. Mackintosh, Mr. G. S. W. Marlow, Prof. L. C. Martin, Sir Richard Paget, Sir Clifford Patterson, Sir Geoffrey Taylor; *Visitors*, Mr. J. J. Abraham, Mr. W. E. Watson Baker, Dr. J. H. Brinkworth, Mr. D. I. Duveen, Mr. F. P. Dunn, Mr. P. Evans, Dr. A. T. Fraser, Sir William Halcrow, Prof. F. L. Hopwood, Mr. L. B. W. Jolley, Mr. D. Northall-Laurie, Dr. E. Talbot Paris, Sir Harry Railing, Prof. D. V. Thompson, Prof. H. E. Watson.

Physical Society: Election of Officers

THE following have been elected officers for 1947–48 of the Physical Society: *President*, Prof. G. I. Finch; *Vice-Presidents*, Sir Edward Appleton, Mr. A. J. Philpot, Prof. H. R. Robinson, Dr. W. D. Wright; *Hon. Secretaries*, Dr. W. Jevons, Dr. H. H. Hopkins; *Hon. Foreign Secretary*, Prof. E. N. da C. Andrade; *Hon. Treasurer*, Dr. H. Shaw; *Hon. Librarian*, Dr. R. W. B. Pearse; *Members of Council*, Dr. W. S. Stiles, Dr. C. H. Collie, Prof. J. D. Bernal, Dr. D. Roaf, Dr. A. C. G. Menzies, Prof. R. E. Peierls, Dr. F. C. Toy, Prof. J. F. Allen, Mr. J. H.

Awbery, Prof. L. F. Bates, Dr. R. C. Evans, Dr. C. E. Wynn-Williams.

The officers for 1947-48 of the four Groups of the Society are as follows: Colour Group: *Chairman*, Mr. J. G. Holmes; *Hon. Secretary*, Dr. W. D. Wright; Optical Group: *Chairman*, Prof. L. C. Martin; *Hon. Secretary*, Mr. E. W. H. Selwyn; Low-Temperature Group: *Chairman*, Sir Alfred Egerton; *Hon. Secretary*, Mr. G. G. Haselden; Acoustics Group: *Chairman*, Mr. H. L. Kirke; *Hon. Secretaries*, Mr. W. H. Allen and Mr. A. T. Pickles.

University of Glasgow: Appointments

The following appointments in the University of Glasgow have been announced: Prof. G. W. Wishart, professor of physiological chemistry, is to become director of post-graduate medical education. Mr. J. R. Anderson has been appointed lecturer in pathology; Dr. W. F. Anderson, lecturer in materia medica; Dr. J. C. D. Brand (of King's College, London), lecturer in chemistry; Dr. S. A. Hutchinson (formerly with the Distillers' Co., Ltd.), lecturer in botany; and Mr. A. C. Robb, Nuffield research assistant in physics.

Congresses

International Conference on the Emission from the Aurora and the Night Sky

An international conference to discuss the emission from the aurora and the night sky is being arranged under the auspices of the Gassiot Committee of the Royal Society. This will be held in London during July 7–11 at the rooms of the Royal Society at Burlington House.

Conference on the Strength of Solids

A detailed programme has now been prepared of the Conference on the Strength of Solids to be held at the H. H. Wills Physical Laboratory, University of Bristol, during July 7–10 (see *Nature*, Feb. 8, p. 193). The topics to be discussed include hardening of metals by internal oxidation (J. L. Meyering, Eindhoven), rate of approach to the ordered state in alloys (M. Weil, Grenoble), mechanical properties of metals at low temperatures (Prof. M. J. Druyvesteyn, Delft), creep in metals (Prof. E. N. da C. Andrade, Dr. E. Orowan and Dr. B. Chalmers), recovery and recrystallization (Prof. W. G. Burgers, Delft), hardness and crystal size (Sir Lawrence Bragg), thermo-electric methods of studying diffusion (C. Crussard, Paris), internal friction in metals (Prof. L. Guillet, Paris), elastic after-effects in iron (Prof. H. B. G. Casimir, Eindhoven) and sintered artefacts (J. H. McKee).

Nuclear Physics in Biological and Medical Sciences

The University of California Medical School, in association with University Extension, University of California, has arranged a course in the application of nuclear physics to the biological and medical sciences. This course will be given at the Medical Center, San Francisco, during June 30–July 18. There will be lectures, laboratory demonstrations and seminars for round-table discussions. The course is open to those interested in the field of medical and biological research. The first week will be devoted to lectures, etc., on the general subject, the second week to the radioactive 'tracers' in biology and medicine and the third to therapeutic and diagnostic aspects of 'tracer' elements. Detailed information can be obtained from Dr. Stacy R. Mettier, head of the Post-graduate Instruction Medical Extension, University of California Medical Center, San Francisco 22, California.

Industrial Utilization of Agricultural Products and of Seaweed

A Colloquium on the Industrial Utilization of Agricultural Products and of Seaweed, arranged by the Irish Chemical Association and the Dublin Section of the Royal Institute of Chemistry, will be held in the Department of Chemistry, University College, Dublin, on July 2 and 3. The meetings will be opened by the Minister for Industry and Commerce of Eire, and the first session will be a general survey opened by Prof. J. L. Simonsen, director of the Colonial Products Research Council, London, who will speak on "Agricultural Products and the Chemical Industry". The second session, on seaweed, will be opened by Prof. J. B. Speakman, professor of textile industries, University of Leeds, with a paper on "The Production, Properties and Uses of Seaweed Rayon". The third session will deal with carbohydrates, and will be opened by a paper by Prof. E. L. Hirst, Sir Samuel Hall professor of chemistry, University of Manchester, on "The Utilization of Carbohydrate Products". On July 3, there will be a Government reception at Phœnix Park, Dublin.

Announcements

Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford, and Prof. P. Karrer, professor of chemistry in the University of Zurich, have been elected *Correspondants* for the Section of Chemistry of the Paris Academy of Sciences. Sir Robert Robinson has also recently been elected a foreign member of the Royal Norwegian Academy of Sciences.

A conversazione of the Royal Society is being held at the Society's rooms on May 29 at 8.30 p.m.

Mr. J. Davidson Pratt, director and secretary of the Association of British Chemical Manufacturers, has been awarded by the American Government the Medal of Freedom with silver palms for exceptionally meritorious work and co-operation with the United States while Controller of Chemical Defence Development at the Ministry of Supply during 1940–45.

The Ministry of Supply announces the following appointments to the Minister's Advisory Council on Scientific Research and Technical Development: Prof. Wesley Austin, Goldsmith's professor of metallurgy in the University of Cambridge; Prof. W. E. Curtis, professor of physics at King's College, Newcastle; Lord Hankey; Prof. Willis Jackson, professor of electrical engineering at the Imperial College of Science and Technology, London; Prof. E. K. Rideal, Fullerian professor of chemistry at the Royal Institution; Mr. S. Robson, of the Imperial Smelting Corporation of Bristol.

Dr. E. C. Amoroso, reader in histology and embryology at the Royal Veterinary College, London, has been appointed to the chair of veterinary physiology in the College.

Erratum. In the communication "Phase-Contrast in the Photomicrography of Metals", in *Nature*, May 10, p. 639, par. 6, for "42-mm. oil immersion" read "2-mm. oil immersion".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Discovery of a New Skull of the South African Ape-man, *Plesianthropus*

BETWEEN 1924, when the Taungs ape-man was discovered, and 1941, when the jaws of the baby Kromdraai ape-man were found, remains of many individuals of this wonderful family, which some of us consider to be nearly related to man, were discovered; sufficient to show that in South Africa we may have the key which will solve the problem of the origin of man. But from 1941 until a few months ago, no further research was undertaken.

In 1946, a book was published on all we know of the South African ape-man; and the world awoke to the possibilities of the wonderful results that might be achieved by the further study of our caves. The United States has come to realize that South Africa is a more promising centre for the solution of the problem than even Java or China; and she seems determined to see that the problem must be solved, and solved soon.

At the beginning of this year, at the special request of General Smuts, I again started to hunt for more 'missing links'. My assistants and I commenced work at Kromdraai and continued there for three months. We found many interesting remains, including a very fine skull of a sabre-tooth tiger (*Megantereon*) and the skull of a large type of 'baboon', which belongs to a new genus; but only one bone that had possibly belonged to an ape-man.

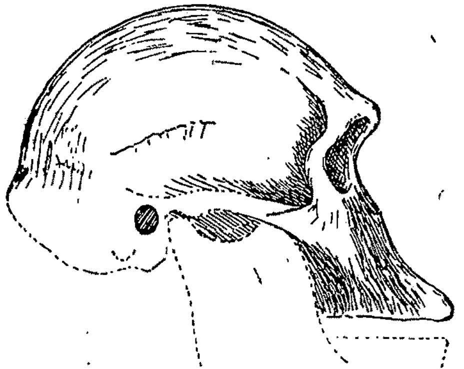


Fig. 1. SIDE VIEW OF SKULL OF OLD FEMALE STERKFONTEIN APE-MAN *Plesianthropus transvaalensis* (BROOM). ⅓ NATURAL SIZE. THE LOWER PART OF THE OCCIPUT AND PART OF THE JUGAL ARCH ARE STILL EMBEDDED IN MATRIX, AND THE LOWER JAW IS NOT PRESENT

Then on April 1 we started work at Sterkfontein, and almost immediately our labours were rewarded by sensational discoveries. On April 8 we found an isolated crushed snout of an adolescent *Plesianthropus* with some beautiful teeth; and a fragment of a snout of a child of possibly three years. This showed the perfect upper milk molars, and a note on the discovery was sent to *Nature* [see issue of May 3, p. 602. Editors]. On April 11 two quite isolated teeth of Sterkfontein apes were found—one the beautiful upper canine of a male of perhaps thirty years, and a lower mol probably of a female of forty years.

But on April 18 a small blast cracked open a blo of breccia, and there in the middle lay a perfect sk without the mandible of an adult *Plesianthrop* with the brain case broken across. In ten days had found the remains of five—possibly six individuals of the Sterkfontein ape-man, *Plesia thropus*, and one of them represented by a comple skull.

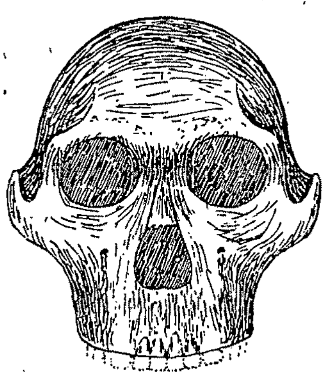


Fig. 2. FRONT VIEW OF SKULL OF OLD FEMALE STERKFONTEIN APE-MAN, *Plesianthropus transvaalensis* (BROOM). ⅓ NATURAL SIZE

The bones are very friable and the matrix not on rather hard lime, but also breccia with many lar broken pieces of chert; it will take many wee before the skull can be completely developed fro the matrix.

Enough, however, has now been done to reve most of the more striking features of the skull. the type skull the brain cavity was filled wi matrix. In the newly discovered skull there only a lining of lime crystals from about ⅛ in. nearly ½ in. in thickness. When this layer is remov we will have every detail of the anatomy of the inn side of the base of the skull. The under surface the base of the skull appears to be just as perfec but it will take some further weeks of preparati to reveal it all.

So far, our labours have been concentrated on t details of the face, and in cleaning the cranial vau The teeth are all lost, but many sockets rema and we can say with much confidence that the sk is that of an elderly female.

The drawings I give will serve to show the gener aspect of the face and the side view. I think the will be very general agreement that the being is n a chimpanzee or even closely allied to any of t living anthropoids, and that, though small, the sk has many resemblances to that of man.

The skull from glabella to opisthocranion is abo 150 mm., and the greatest parietal width is abo 100 mm. It is thus seen to have an index of abo 66, and to be extremely dolichocephalic. As ye we can only give a roughly approximate size for t brain cavity, but it seems probable that it will about 500 c.c.

Of course, it will take many weeks before the sk is completely worked up and a full account can published, but it seems well that the world shou know that such a valuable skull has been discover

R. BROOM

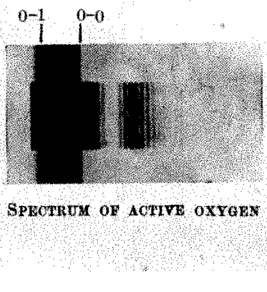
Transvaal Museum,
Pretoria.
April 2.

Active Oxygen

THE light of the night sky has excited increased attention since the end of the War; from the practically minded student of rockets and from astronomers, as well as from students of the upper atmosphere. The astronomer is particularly interested because of the effect of this radiation on his observations. To the student of the upper atmosphere, this radiation has held out a promise of information concerning the composition of the upper air, as well as concerning fundamental processes there. Because of the difficult problem presented by spectroscopy of the light of the night sky, there are still many unidentified radiations in its spectrum, as well as inadequately studied regions. In every review of the contributions of spectroscopy to the study of the upper atmosphere, attention is directed to the desirability of further laboratory investigations of the spectra of O_2 and N_2, and the desirability of obtaining emission spectra of ozone and the oxides of nitrogen. It has been suggested that a search along these lines may yield a satisfactory identification of the strong ultra-violet band at λ3556 A.

These facts, and some recent observations by Stebbins, Whitford and Swings[1] at Mt. Wilson on one hand, and by R. Herman, L. Herman and J. Gauzit[2] at the Lyons Observatory on the infra-red spectrum of the night sky on the other, led me to an extended study of the auroral afterglow in the infra-red. A particularly good nitrogen auroral afterglow at very low pressures was studied, and in time the intensity of the afterglow went down considerably, because of the decrease in pressure which resulted from the clean-up of the nitrogen. It was found that under these conditions the addition of relatively small quantities of oxygen restored the intensity of the afterglow in a very effective manner. This suggested that increasing the amount of oxygen might lead to interesting results, and this was done. It should be mentioned first that the neutral oxygen molecule does not readily show an emission spectrum. A part of the main absorption system observed by Schumann has been observed in emission by Runge, and hence the name Schumann–Runge bands for these famous ultra-violet bands. Hopfield reported an emission spectrum in the region below λ 2218 A. consisting of a single progression. Other band systems, much too few in number and all consisting of transitions from the ground state to low-lying metastable states, have been observed in absorption in gaseous and liquid oxygen. The most famous of these are the so-called atmospheric bands, $A^1\Sigma \leftarrow X^3\Sigma$, observed in atmospheric absorption (especially the solar spectrum), and also observed in the laboratory by absorption through pure oxygen. It is this system which has now been observed for the first time in emission in the afterglow in oxygen, which resulted from the above procedure.

The name 'active oxygen' will be used to identify this phenomenon, just as the name 'active nitrogen' was given to the similar phenomenon in nitrogen.



SPECTRUM OF ACTIVE OXYGEN

The spectrum of the afterglow of active oxygen which is reproduced shows two members of the atmospheric system of oxygen, which are readily identified as 0–0 and 0–1 by comparing them with the first positive system of nitrogen which is superposed. Using hypersensitized Eastman *IN* plates, it is easy to obtain a good spectrogram in a time equal to that necessary for the nitrogen afterglow. It is quite likely that further studies of this afterglow will aid in the study of the physics of the upper atmosphere.

J. KAPLAN

University of California,
Los Angeles, California.
Feb. 14.

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[1] Stebbins, Whitford and Swings, *Astrophys. J.*, **101**, 39 (1945).

[2] Herman, R., Herman, L., and Gauzit, J., *Nature*, **156**, 114 (1945).

Structure of 'Terylene'

ARISING from the recent communication by Prof. W. T. Astbury and Mr. C. J. Brown[1] concerning the structure of 'Terylene', we wish to place on record the earliest investigation of its structure by the X-ray method. The results recently reported by Astbury and Brown from work done in 1944 are in general agreement with those which we obtained some two years earlier.

Early in 1942, the Controller of Chemical Research, Ministry of Supply, learned of the work of Mr. J. R. Whinfield and Dr. J. T. Dickson (of the Calico Printers' Association, Ltd.) on polyethylene terephthalate[2], and requested the Chemical Research Laboratory, D.S.I.R., to assist in its further development. As a result, almost the first step taken was to arrange for the National Physical Laboratory to carry out an X-ray examination of various 'Terylene' samples supplied by Mr. Whinfield and Dr. Dickson; this work was completed by July 7, 1942.

The granular powder produced by cooling a nitrobenzene solution of 'Terylene' gave the pattern shown in Fig. 1. The well-defined system of rings, corresponding to lattice-spacings of 10·5, 5·4, 5·0, 4·1, 3·9 and 3·4 × 10^{-8} cm., indicates that the material is definitely crystalline in the sense that neighbouring molecular chains bear a regular spatial relation to each other.

Slow cooling of molten 'Terylene' produces an opaque material which gave the pattern shown in Fig. 2. This is identical with Fig. 1, though the rings are somewhat sharper. The material has therefore the same structure, and the greater sharpness may be due to a larger particle size.

When molten 'Terylene' is shock-cooled, a translucent product is obtained; this gave the pattern shown in Fig. 3, which contains two diffuse haloes. The inner halo corresponds to the inner ring (spacing 10·5 A.) of the previous forms. The outer halo corresponds to the outer group of diffraction rings of the previous forms; the rings have diffused together to form a broad halo. The molecular structure is therefore a heavily distorted form of the regular structure shown by the previously described crystalline forms.

Shock-cooled filaments may be cold-drawn into 'Terylene' fibres, and these gave the pattern shown in Fig. 4. This shows that very pronounced orientation of the molecules along the length of the fibre has taken place, the orientation being complete to within about 5°. The orientation is indicated by the con-

Fig. 1

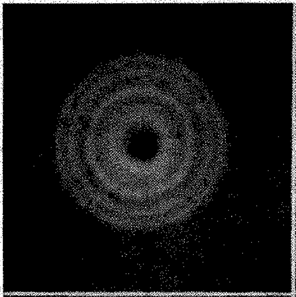
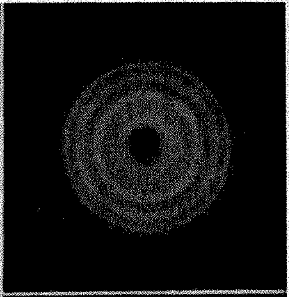


Fig. 2



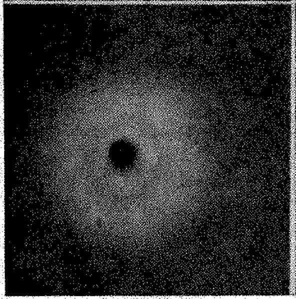


Fig. 3

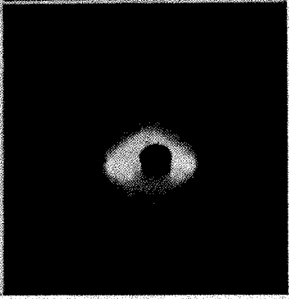


Fig. 4

centration of the intensity of the rings to a few points on the circumference. The diameters of the rings, on which the intensity maxima are formed, are the same as the diameters in the previous crystalline forms, indicating that the basic molecular structure is the same. It will be seen that the maxima are not so sharp as the rings shown, for example, in Fig. 2; in aligning the molecules along the length in cold-drawing, some of the distortion marking the shock-cooled material is retained.

This note is published by permission of the Chief Scientist, Ministry of Supply, and of the directors of the Chemical Research and National Physical Laboratories.

D. V. N. HARDY
W. A. WOOD

Chemical Research Laboratory,
and
National Physical Laboratory,
Teddington.
Feb. 14.

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[1] *Nature*, **158**, 871 (1946).

[2] Whinfield, J. R., *Nature*, **158**, 930 (1946).

Electrical Conductivity of River, Rain and Snow Water

"THE DATA OF GEOCHEMISTRY", by the late F. W. Clarke, is a mine of information on river waters, their variation with geological formation and Joly's 'cyclic sodium' transported in the air and brought down by rain. These phenomena are simply studied by measurements of electrical conductivity at 0° C. Thus $C \times 10^6$ for Plymouth tap-water varied during 1923–24 from 25 to 28; the values found on July 7, 1923, and September 26, 1923, were 27 and 28—identical respectively with those of July 5, 1945, and September 19, 1945. The *p*H varied from 6·4 to 6·8 during the year. It was with some surprise that I found rain-water, collected at Downderry on the Cornish coast during a downpour on March 12, 1946, to have a conductivity 24, with *p*H 6·6. Rain at Plymouth on March 13, 1946, had conductivity 55 and *p*H 4·0. During the night of September 19–20, 1946, rain at Antony, Cornwall, had conductivity 28, the typical September figure for Dartmoor water. Clean snow at Downderry on January 24, 1947, gave 44, and a Plymouth sample of January 25, 1947, gave 72 for conductivity. The latter was taken from the middle of the snow blanket and was, on thawing, surprisingly sooty. Plymouth rain of January 8, 1947, had conductivity 70, close to that of snow.

The country rain samples, with conductivities 24 and 28, had come with south-westerly air, clean from the sea. Thus Dartmoor water derives almost all its electrolytes from sea-salt, but contains from 3·1 to 3·5 parts per million of silica, and colouring matter equivalent to 0·26–0·40 p.p.m. of the yellowish tint given in the silica reaction. The conductivity of water from a calcareous source is about ten times as great. On diluting sea water with 'conductivity water' of conductivity 1 or less, a curve was obtained relating dilution to conductivity and showing that country rain represents sea water diluted to rather less than 1 in 2,000. The purest British natural water met with was the Aberystwyth town supply, conductivity 19.

Early in July 1945, however, samples of river water were flown to Britain from Ceylon. These were astonishingly pure and gave conductivities 10–20. The error due to solubility of the glass appeared to be negligible, and the purest sample corresponded to sea water diluted slightly less than 1 in 5,000. Since the sea water from the English Channel had salinity $35{\cdot}2\,^{0}/_{00}$, or chlorine $19{\cdot}4\,^{0}/_{00}$, the purest sample, with conductivity 10, contained 3·9 parts per million chloride. The amounts may seem small; but it should be remembered that phosphate in natural waters is reckoned in parts per hundred or per thousand million, and upon these traces the production of all water-living organisms depends.

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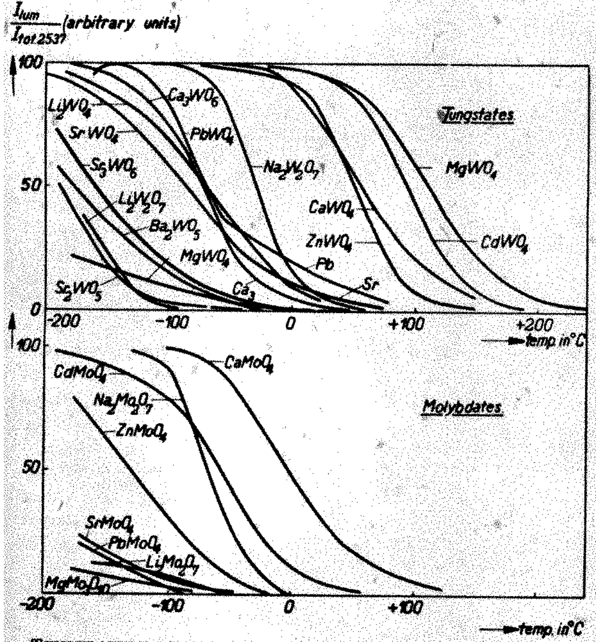
March 12.

Fluorescence of Tungstates and Molybdates

THE tungstates of calcium, strontium, magnesium and zinc, and the molybdates of calcium are known to show luminescence upon excitation by cathode rays or short-wave ultra-violet radiation. It is commonly assumed that this luminescence is characteristic of the tungstate and molybdate groups. If this is true, there must be a reason why other tungstates and molybdates are found to be non-luminescent. Studying a number of different tungstates and molybdates in this Laboratory, we have found this reason to be the temperature-quenching.

Tungstates and molybdates of zinc, magnesium, cadmium, calcium, strontium, barium, lead, lithium and sodium have been prepared by the following method. Oxides or carbonates of the elements mentioned were mixed in stoichiometric proportion with tungstic or molybdic acid and a little water. The mixture was dried on a water bath and fired at temperatures below the melting point of the particular system, but high enough to guarantee good crystallization. These temperatures varied between 530° for lithium molybdate to 1,100° for most of the tungstates. One sample of magnesium tungstate was heated to a higher temperature (1,300° C.) in order to obtain the high-temperature α-form[1].



TEMPERATURE-DEPENDENCE OF THE FLUORESCENCE OF TUNGSTATES AND MOLYBDATES FOR EXCITATION BY λ 2537 A. (MAXIMA ARBITRARILY FIXED AT 100-LEVEL). (THE MODIFICATION OF MAGNESIUM TUNGSTATE THAT IS QUENCHED AT LOW TEMPERATURES IS THE α-FORM)

Nearly all substances investigated show fluorescence at a low temperature upon excitation by λ 2537 A. (see graph). The temperature-range in which quenching occurs is different, not only for compounds of different composition, but also for the same compound in different modifications (α- and β-magnesium tungstate). For the few tungstates for which no luminescence was found, the quenching range is probably situated beyond −180° C., so that fluorescence may be expected at extremely low temperatures. The quenching-ranges of tungstates are, on the whole, at higher temperatures than those of the molybdates. This explains why many more tungstates than molybdates are known to show luminescence.

A more complete report of our investigations, including measurements of absorption and fluorescence spectra, is to be published elsewhere[2].

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Eindhoven.
Feb. 21.

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[1] Hüniger, cited by Birus, K., *Ergeb. Exakt. Naturw.*, **20**, 221 (1942). Hill, C. G. A., *Trans. Farad. Soc.*, **42**, 666 (1946).

[2] Kröger, F. A., "Some Aspects of the Luminescence of Solids" (Elsevier Publishing Co., Amsterdam and New York, 1947), in the press.

Gas Discharge in Air of Atmospheric Pressure at Very Low Voltage

IT has been observed that a potential difference of as little as 15 V. applied between two semi-conductors in contact with each other, or alternatively, of a semi-conductor in contact with a metal, may sustain a gas discharge in air of atmospheric pressure.

The semi-conductors used were grains of pale green carborundum, selected for paleness from commercial No. 8 mesh samples. The grains were either stuck with solder into metal holders, or laid on a hardened and polished steel block and a second similar block laid on top of the grain. The potential was taken from the sliding contact of a low-impedance potentiometer across D.C. mains and measured by means of an ordinary voltmeter.

The gas discharge was of a pale bluish-mauve colour, and if viewed through a low-power microscope was seen to consist of streamers from grain to grain (or grain to steel block) near the point of contact. The streamers were several microns long.

The phenomenon could not be observed in every case. The potential range at which it would occur is from less than 15 V., but more than 13 V. to about 50 V. At higher potentials the contact area would as likely as not become incandescent and, therefore, so highly conductive that equipotential surfaces in the crystal would move outwards, bringing the areas of the crystal where the potential difference across the gap reaches 15 V. into regions where the air-gap becomes too wide.

A phenomenon like this was expected to occur only in the immediate neighbourhood of the contact, that is, where the air-gap was comparable with the mean free path of gas molecules. Where in fact it occurs, the path along the streamer contains many hundred mean free paths, and it is therefore believed that radiation from streamer to streamer plays an essential part in the excitation mechanism.

Bay and Szigeti[1] described luminous phenomena on carborundum crystals. Similar phenomena were also observed by me. They are apparently due to incandescence at the point of contact and occur if the current is allowed to build up to values in excess of those at which gas discharges can occur. Light travelling from the incandescent zone inside the crystal emerges from its whole surface and gives the appearance of the whole crystal being luminous. As the light is due to the incandescence of a substance which disintegrates below 2,000° K., and which radiates rather like a black body, it is originally of a yellow tinge. After transmission through a more or less coloured crystal, it emerges filtered sometimes as a pure white and sometimes as a brilliant yellow. The bluish-mauve colour of the gas-discharge described above has never been observed to emerge from the mass of the crystal. There is also no low-voltage limit for sustaining this mass glow once it has been initiated.

My observations are now some years old. Pressure of other work has since, and will presumably in the future, prevent my following the matter up further.

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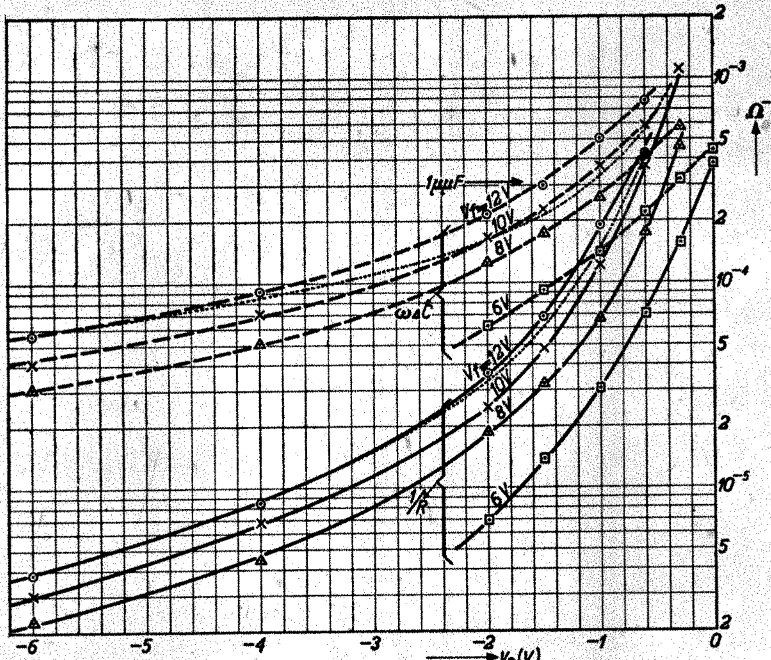
[1] U.S. Patent No. 2,254,957, September 2, 1941, and an earlier Hungarian patent of October 23, 1939.

Total Emission Damping in Diodes

A FEW months ago, C. N. Smyth[1] published preliminary results on a new source of energy loss in space-charge-limited diodes at high frequencies. This energy loss was due to the space-charge between the electrodes, and hence it was called 'total emission damping'; it is a transit time effect occurring at ultra-high frequencies only. The same effect was observed a few years ago at this Laboratory at about 100 Mc. After reading Mr. Smyth's communication we took up this subject again.

We carried out measurements at 5·8 m. wavelength on a diode having an emitting cathode area



1/*R* AND $\omega\Delta C$ AS A FUNCTION OF V_a FOR HEATER VOLTAGES V_f OF 12 V., 10 V., 8 V. AND 6 V. RESPECTIVELY

of about 10 cm.^{2} and an anode–cathode distance of 0·1 cm. The results are shown in the accompanying graph, in which the conductive part $1/R$ (full lines) and the reactive part $\omega\Delta C$ (broken lines) of the additional admittance due to the space-charge between anode and cathode is plotted against the anode voltage V_a (not corrected for contact potentials) with the heater voltage V_f as a parameter (heater voltage V_f = 12 V., 10 V., 8 V. and 6 V. respectively).

The graph also shows the dotted curves $C_1 V_a^{-1}$ (upper curve) and $C_2 V_a^{-2}$; the constant C_1 is chosen so that the first curve coincides with the curve $\omega\Delta C$ (for V_f = 12 V.) at $V_a = -6$ V., the constant C_2 so that the second curve coincides with the curve $1/R$ (for V_f = 12 V.) at $V_a = -6$ V. These curves indicate that $\omega\Delta C$ and $1/R$ are approximately proportional to V_a^{-1} and V_a^{-2}, respectively. $\omega\Delta C$ and $1/R$ are only slightly dependent upon the saturation current of the cathode. Taking the saturation current at V_f=6 V. as a unit, we measured at V_f=8 V., 10 V. and 12 V., saturation currents of 14, 140 and 1,100 units, respectively. This shows that a change in saturation current by a factor 100 only results in a change in $\omega\Delta C$ and $1/R$ by about a factor 3 or less. It would be expected from a theoretical point of view that the dependence of $\omega\Delta C$ and $1/R$ upon the saturation current will be more pronounced if either the cathode–anode distance or the saturation current is smaller (compare the curves for V_f = 6 V. and V_f = 8 V.).

It is also to be expected from a theoretical point of view that ΔC would scarcely depend on frequency, and that $1/R$ would be proportional to ω^2, except for the highest frequencies.

A full account of our investigations will be published elsewhere.

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N. V. Philips' Gloeilampenfabrieken,
Eindhoven.
Feb. 13.

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[1] Smyth, C. N., *Nature*, **157**, 841 (1946).

Determination of the 'Loading' in Paper by Microradiography

THE development of microradiography as a result of the researches of Goby, Dauvillier, Lamarque, Trillat, and of Maddigan, Ball, Clark, etc., is well known. The latter recommended the use of characteristic radiation for metallurgical applications. One may endeavour to generalize his ideas in other fields.

In this respect, we have been able to show that it is possible to obtain information regarding the 'loading' in paper by using a characteristic radiation (iron $K\alpha$, or copper $K\alpha$).

The 'Metalix' tube used is run at a tension of 25 kilovolts. The samples are placed in a circular camera at 2 cm. from the window. The emulsion is a Lippmann-Gevaert film placed in direct contact with the sheet to be examined. For an intensity of 15 milliamperes, the time of the exposures did not exceed five minutes. After development, the image was enlarged by a microscope with a photographic camera.

Figs. 1 and 2 correspond to bisulphite papers with 'loadings' of different natures amounting to 10 per cent. The 'loading' appears in white, and the initial enlargement is of a range of 125 diameters. A comparison between the photographs shows the interest of the method.

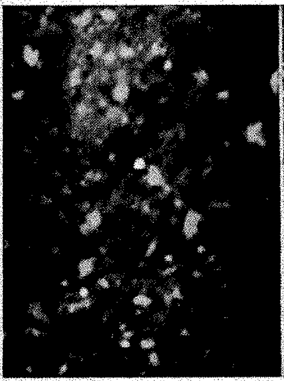

Fig. 1

Fig. 2

We have taken microradiographs of many samples of paper 'loaded' with different materials (titanium oxide, kaolin, etc.) at different concentrations. With characteristic radiation it is possible to control the loading in paper and even to determine approximately its proportion[1]. In order to obtain information regarding the actual fibres, it is necessary to use a greater wave-length (for example, chromium $K\alpha$) or a low-voltage tungsten tube.

The above investigation was carried out for the Fonds du Centenaire de l'A.I.Lg.

H. J. LAMBOT

Laboratoire d'Applications des Rayons X,
University of Liège.

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[1] Lambot, H. J., *Bull. Soc. Sci. Liège* (1946).

Equivalence of Mass and Energy

THE following describes an ideal experiment from which the law of equivalence of mass and energy may be derived by using means employed in elementary physics.

Suppose a cylindrical tube entirely evacuated at the ends of which mirrors μ_1 and μ_2 are placed perpendicular to the generating line of the cylinder, and let the coefficient of absorption of μ_1 and μ_2 be zero. A ray of light perpendicular to the mirrors will be therefore reflected from μ_1 and μ_2 for an indefinitely long time.

Consider a monochromatic ray composed of photons, the mass of each photon being m and the velocity of each being c (in vacuum). The impulse of each photon is therefore equal to mc, and after reflexion it reverses its direction only, if we assume that photons have absolute elasticity (an assumption made, for example, in the Compton effect).

Applying the method used in the elementary kinetic theory of gases, we get

$$p = 2mc \, . \, N \, . \, \frac{c}{2a} \, . \, \frac{1}{S},$$

where p signifies the mean pressure of a bundle of parallel rays on one of the mirrors, N is the total number of photons in the tube, a is the length of the tube, and S is its area of cross-section.

Substituting the volume V for aS,

$$pV = mc^2N.$$

An infinitesimal parallel displacement of one mirror towards the other will diminish the volume of the tube by dV. The amount of work done by this displacement is pdV. Evidently, this amount is equal to the energy increase of the 'photonic gas', or of all its N photons together.

Differentiation of the preceding formula gives

$$p \, . \, dV = c^2N \, . \, dm,$$

since the number of photons does not change and the velocity c (according to a postulate of the theory of relativity) remains unchanged too.

Indicating by dE the energy increase of each photon, we get

$$\frac{p\,dV}{N} = dE = c^2dm.$$

Moving the mirrors towards each other by a finite distance and integrating, we get

$$E - E_0 = c^2(m - m_0);$$

or

$$E - mc^2 = E_0 - m_0c^2 = \text{constant},$$

for any pair of values of E and m.

Hence

$$E = mc^2 + \text{constant}.$$

Since an expression of energy leaves an additive constant free, we may so choose the latter that

$$E = mc^2.$$

The above proof of this fundamental formula applies, of course, only to the special case of the energy of photons.

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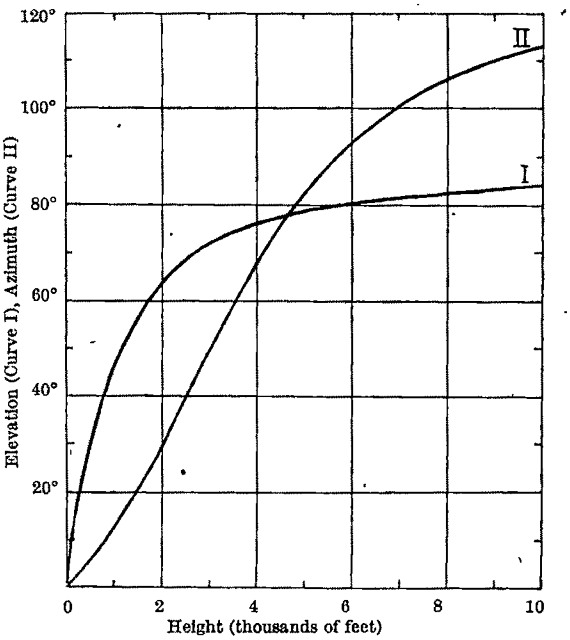
An Azimuthal Method of Measuring Cloud Height with a Searchlight

THE normal method of determining the height of the cloud base at night is to direct a vertical searchlight beam on to the cloud and measure the angle of elevation E of the spot of light from a point at a known horizontal distance L from the searchlight. The height h of the cloud base is then given by $h = L \tan E$. The length L of the base-line is normally about 1,000 ft.

The precision of the method clearly depends upon the accuracy with which the angle of elevation E can be measured. In practice, a limit to the observational accuracy is set by the fact that the spot of light is never sharply defined, because of the diffuse nature of the cloud surface. A reading to the nearest whole degree is therefore the best that can be expected.



CURVE I: VARIATION OF ELEVATION WITH HEIGHT OF CLOUD; VERTICAL BEAM; BASE-LINE, 1,000 FT. CURVE II: VARIATION OF AZIMUTH WITH HEIGHT OF CLOUD; SEARCHLIGHT AT 76°; BASE-LINE, 1,000 FT.; DIRECTION OF BEAM, 45° FROM DIRECTION OF BASE-LINE

Curve I shows the relationship between E and h for the case $L = 1{,}000$ ft. It will be seen that for heights exceeding 4,000 ft. the rate of increase of E with h is very small. The increase of elevation between $h = 5{,}000$ ft. and $h = 10{,}000$ ft. is, in fact, only 5·6°. As E can only be measured to the nearest degree, cloud heights in this range can therefore only be measured to about the nearest 1,000 ft. The new code for height of cloud adopted by the International Meteorological Committee at Paris in 1946 provides for reporting observations to the nearest 300 ft. in this range. It is necessary, therefore, to consider means of improving upon the accuracy obtainable by the present method.

If the searchlight beam is tilted out of the vertical in a direction transverse to the line of sight, both the azimuth and elevation of the spot of light will vary with the height of the cloud. It is possible, therefore, to make use of the variation of azimuth to determine the height of the cloud. If α is the angle of inclination of the beam to the horizontal plane, β is the angle of orientation of the beam and θ is the azimuth of the spot of light (β and θ both being measured from the direction of the base line as zero), it is readily shown that

$$h = L \tan \alpha \,.\, \sin \theta \,.\, \operatorname{cosec} (\beta + \theta).$$

It is found that by choosing suitable values for L, α and β, one obtains a relationship between h and θ which is very much more satisfactory for measuring heights exceeding about 2,000 ft. than is possible by using the angle of elevation with a vertical beam. Curve II has been drawn for the case $L = 1{,}000$ ft., $\alpha = 76°$, $\beta = 45°$. It will be seen that for heights above 2,000 ft. Curve II is everywhere substantially steeper than Curve I. In particular, the change of θ between $h = 5{,}000$ ft. and $h = 10{,}000$ ft. is 31°, as compared with a change of 5·6° in E for the same difference of height. The values of α and β used for drawing Curve II are not necessarily the optimum values or those which will be adopted after trials of the method have been carried out.

For heights below about 2,000 ft. the rate of change of elevation with height is very rapid, and is, in fact, rather more rapid with a tilted beam oriented at 45° to the direction of the base line than with a vertical beam. It is concluded, therefore, that the best method of applying the searchlight method is to use the inclined beam system here described, making measurements of elevation for heights up to 2,000 ft., and of azimuth for greater heights.

A fuller discussion of the method will be published elsewhere. I have to thank the Director of the Meteorological Office for giving me permission to publish this preliminary note.

E. G. Bilham

Meteorological Office,
Dunstable, Beds.
March 24.

Electrical Properties of Paint Films on Metals

As part of an investigation on the protective properties of paint films on metals immersed in sea water, a study is being made of the electrical characteristics of such films and their changes with time.

The first approach consisted in following the electrode potential of painted mild steel plates immersed in an artificial sea water, on the lines adopted by earlier workers[1,2], but extending the period of test to cover the various stages of breakdown of the paint film. Plates were abraded, degreased and painted with two coats of an anti-corrosive marine paint, and completely immersed vertically, with provision for an electrical lead shielded from contact with the sea water. The results obtained for several paint systems show that there is a characteristic fall in potential during the first few hours (not well shown on the scale of Fig. 1); after an intervening period of somewhat fluctuating potential, there is a rise to a maximum with a final decline (Curve B, Fig. 1). The incidence of this final decline coincides with the time at which rusting begins to spread rapidly (cf. Curve A, Fig. 1).

The apparent ohmic resistance and the apparent capacity of the paint film were next investigated, using a Wheatstone bridge with a variable non-inductive resistance in parallel with a variable condenser in one arm of the bridge, in order to balance the resistance and capacity of the cell consisting of two similarly painted plates. Measurements have so far been made only at a frequency of 1,000 cycles per second. The results suggest that the resistance and capacity, especially the latter, are much more sensitive to breakdown of the paint film than is the electrode potential. The onset of rusting is indicated by a sudden large increase in capacity (Fig. 2) and a marked fall in resistance (Fig. 1, Curve D). The curves in Fig. 2 (drawn on a larger scale than Fig. 1) show the large capacity changes due to the initial breakdown of paint films consisting respectively of one, two, or three coats.

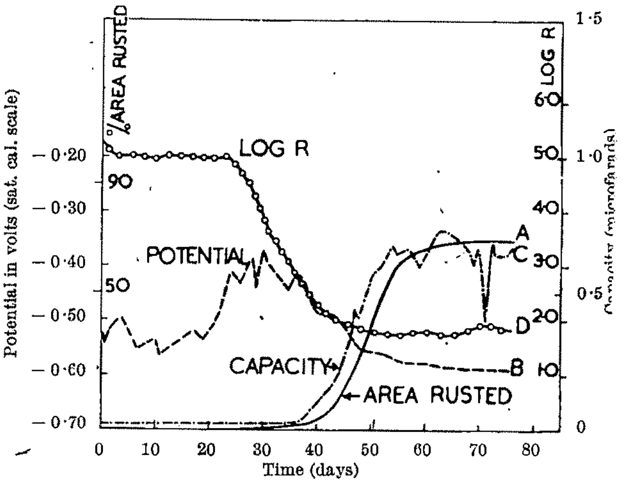


Fig. 1. Relationship between area rusted and changes in electrical properties of paint films on steel

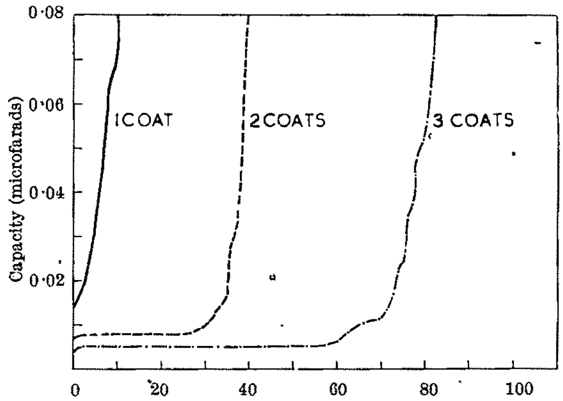


Fig. 2

The general correlation of the changes in all the electrical properties (potential, resistance and capacity) with the gradual spread of rusting over a period of 76 days may be seen from Fig. 1. The figures for rusting represent approximate areas covered by rust; the true corroded area is appreciably less, but this can be estimated only after stopping the test and removing the paint and rust. Curve A (Fig. 1) does, however, fairly indicate the rate of spread of rusting, and it can therefore be used as a criterion for interpreting the changes in electrical properties of the paint film.

The values for capacity and resistance given in the graphs are the equivalent parallel capacity and the equivalent parallel resistance, as measured directly. The precise interpretation of these results needs further consideration and will be dealt with in a subsequent communication. It is evident, however, that the conception of the paint film as a 'leaking condenser' must provide the general explanation of the phenomena observed.

It is suggested that the technique should prove valuable as a sensitive means of following quantitatively the breakdown of paint films on metals exposed to aqueous solutions. The method has possible alternative applications to the study of other types of protective coatings and of thin films produced by corrosion inhibitors.

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D. M. BRASHER
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Teddington, Middlesex.
March 4.

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[1] Burns, R. M., and Haring, H. E., *Trans. Electrochem. Soc.*, **69**, 169 (1936).

[2] Haring, H. E., and Gibney, R. B., *Trans. Electrochem. Soc.*, **76**, 287 (1939).

Analgesic Activity in Compounds Related to Amidone

AMIDONE (*dl*-2-dimethylamino-4 : 4-diphenylheptan-5-one) or Hoechst 10820 was made and examined by the I.G. workers at Hoechst during the War. Short preliminary accounts of the properties of this compound have appeared in both the British and American literature, where the activities of some analogous compounds are also described[1,2,3].

As the series is so obviously interesting, we have prepared, in addition to amidone, some of its analogues by condensing diphenylacetonitrile with various aminoalkyl chlorides and treating the resulting basic nitriles with Grignard reagents. Details of some of these compounds are given in Table 1.

In general, the hydrochlorides were very soluble in water, whereas the other salts referred to in Table 1 crystallized readily from aqueous solution.

The analgesic, toxic and respiratory depressant actions have been compared by one of us (R. H. T.) with those of morphine, pethidine and a sample of the lævo form of amidone (*l*–820), obtained from Germany.

Analgesic action was estimated by the method described by Thorp[4], using groups of six rats with varied doses of the compounds compared with doses of 1 or 2 mgm./kgm. of morphine. Respiratory depression was measured in unanæsthetized rabbits after a single dose of the compound under test, the respiratory minute volume being recorded by the method of Gaddum[5]. The doses were adjusted to produce a steady depression of approximately 50 per cent of the normal resting level for at least one hour. The figures for toxicity are the approximate *L.D.*50 values for intravenous injection in mice. The pharmacological results are given in Table 2.

TABLE 2

Compound	Toxicity (mgm./kgm.)	Analgesic activity		Respiratory depressant activity	
		Equiactive doses (mgm./kgm.)	Approximate ratio	Equiactive doses (mgm./kgm.)	Approximate ratio
Morphine	—	2·0	(1·0)	5·0	(1·0)
Pethidine	60·0	15–20	0·15	30·0	0·15
l-820	10·0	1·0	2·0	1·5	3·3
70*C*47	35·0	30–40	0·05	No effect	—
10820	12·5	2·0	1·0	5·0	1·0
72*C*47	25·0	15–20*	0·1	Slight at 10·0	—
97*C*47	20·0	30–40*	0·05	No effect	—
133*C*47	12·0	30–40*	0·05	No effect	—
68*C*47	20·0	4–6	0·4	10·0	0·5
69*C*47	—	60*	0·03	No effect	—
67*C*47	20·0	40*	0·05	No effect	—

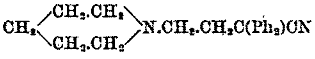
* In the case of these compounds, doses smaller than the equiactive dose were used in the test, the response obtained being similar to that for 1·0 mgm./kgm. of morphine.

No figure is given for the toxicity of morphine upon intravenous injection into mice, since these animals are not easily killed by morphine and the *L.D.*50 value (approximately 300 mgm./kgm.) does not correspond to that given by larger animals such as the rabbit.

With compounds having less than 1/10 of the analgesic activity of morphine and relatively high toxicity, the assessment of analgesia is not very reliable, since the doses approach the toxic level. With true analgesic drugs, a graded response is given with doses of 0·1 to 0·25 of the *L.D.*50 toxicity dose for mice.

The results show that, in compounds bearing the 2-dimethylaminopropyl group, analgesic action is optimal in the ethyl ketone 10820, but much less in the shorter- or longer-chain compounds. The radical alterations in the basic side-chain in compounds 68*C*47 and 133*C*47 result in decreased analgesic activity, but again the ethyl ketone is the more potent. Mice injected with compound 68*C*47 show complete narcosis with doses insufficient to cause

TABLE 1

Ref. No.	Name of compound	Structural formula	M.P.'s of base and salts				
			Base	HCl	HBr	HI	HNO_3
70*C*47	2-Dimethylamino-4:4-diphenylhexan-5-one	$CH_3.CH(NMe_2)CH_2.C(Ph_2)COCH_3$	73	186*	194	181	144
10820	2-Dimethylamino-4:4-diphenylheptan-5-one	$CH_3.CH(NMe_2)CH_2.C(Ph_2)COC_2H_5$	76	231*	224*	198	109
72*C*47	2-Dimethylamino-4:4-diphenyloctan-5-one	$CH_3.CH(NMe_2)CH_2.C(Ph_2)CO(CH_2)_2CH_3$	Oil	v. deliquescent	88*	156	96
97*C*47	2-Dimethylamino-4:4-diphenylnonan-5-one	$CH_3.CH(NMe_2)CH_2.C(Ph_2)CO(CH_2)_3CH_3$	Oil	84*	99	96	—
133*C*47	1-Piperidino-3:3-diphenylpentan-4-one	$CH_2\left\langle\begin{matrix}CH_2.CH_2\\CH_2.CH_2\end{matrix}\right\rangle N.CH_2CH_2C(Ph_2)COCH_3$	Oil	—	162*	158	—
68*C*47	1-Piperidino-3:3-diphenylhexan-4-one	$CH_2\left\langle\begin{matrix}CH_2.CH_2\\CH_2.CH_2\end{matrix}\right\rangle N.CH_2CH_2C(Ph_2)COC_2H_5$	Oil	—	192*	—	—
69*C*47	1:1-Diphenyl-3-dimethylaminovaleronitrile	$CH_3CH(NMe_2)CH_2C(Ph_2)CN$	91	182*	178	203	169
67*C*47	1:1-Diphenyl-3-piperidinobutyronitrile	 $CH_2\left\langle\begin{matrix}CH_2.CH_2\\CH_2.CH_2\end{matrix}\right\rangle N.CH_2.CH_2C(Ph_2)CN$	73	196*	186	152	155

* Compounds tested pharmacologically, and to which the reference numbers apply.

respiratory arrest, whereas the latter symptom is the first to appear after large doses of amidone.

In animal experiments the respiratory depressant activity in these compounds parallels analgesic activity, so that, broadly speaking, in effective compounds a given degree of analgesia is accompanied by a similar degree of respiratory depression.

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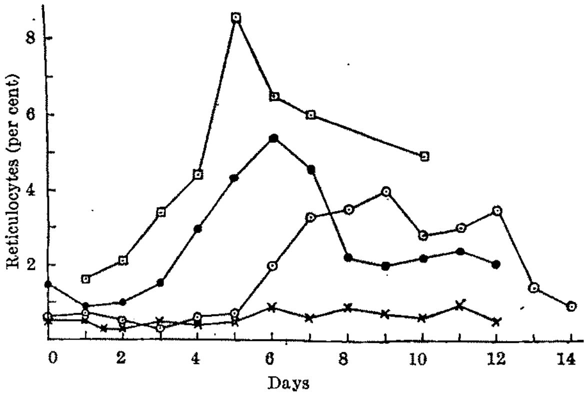
Thio-thymine (2-Thio-5-Methyl-Uracil)

SPIES *et al.*[1] have reported the value of 5-methyl-uracil (thymine) in the treatment of pernicious anæmia. Jacobson and Williams[2] have suggested the use of splenectomized rabbits for the assessment of anti-anæmic factors, and Bavin and Middleton[3] have shown that thymine causes a reticulocytosis when injected into such splenectomized rabbits. We have used a similar method for the study of the hæmopoietic activity of various thymine derivatives.

Di-hydro-thymine-4-carboxylic acid when injected intramuscularly into splenectomized rabbits in dosages of 100 mgm./kgm. does not cause a reticulocytic response, whereas 2-thio-5-methyl-uracil (in 100 mgm./kgm. dosage) and 2-amino-5-methyl-uracil (100 mgm./kgm.) do (see graph).



●, Thymine, 100 mgm./kgm. intramuscularly
○, Thio-thymine, 200 mgm./kgm. intramuscularly
×, Di-hydro-thymine-4-carboxylic acid, 100 mgm./kgm. intramuscularly
□, Amino-thymine, 100 carboxylic acid, 100 mgm./kgm. intramuscularly

The 2-thio-5-methyl-uracil compound (thio-thymine) is particularly interesting in that it contains the —NH.CS.NH— grouping which Astwood[4] has suggested is the common radical in many anti-thyroid compounds. We have found that when this compound is given by mouth to 21-day old female rats (Wistar) in a dosage of 40 mgm./100 gm. daily for ten days and the rats then sacrificed, the thyroids of these rats are grossly enlarged and hyperæmic. Histological examination of the glands revealed colloid loss, increased vascularity, and hyperplasia of the acinar epithelium. A dosage of 20 mgm./100 gm. daily by mouth for ten days did not cause any very marked thyroid changes.

Hence thio-thymine has both anti-thyroid properties and hæmopoietic activity. Moreover, the daily injection of 100 mgm./kgm. intramuscularly for ten days to splenectomized rabbits does not affect the white blood-cell counts of these animals. Again, the intramuscular injection of 20 mgm./kgm. daily (higher dosages caused death of some rabbits from pulmonary œdema) into normal rabbits for ten days produced, if anything, a polymorphonuclear leucocytosis (see table). Thio-thymine would seem, therefore, to be free from the depressant action on the bone marrow which has been noted in the use of thiourea[5] and thiouracil[6].

We are indebted to Mr. F. Fowler of Benger's Ltd. for preparing the above compounds.

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Treatment of Myasthenia gravis with Di-isopropylfluorophosphonate

A NUMBER of papers have appeared recently dealing with di-isopropylfluorophosphonate, which was prepared by McCombie and Saunders[1] in 1941 and found by Adrian, Feldberg and Kilby[2] to cause a prolonged inhibition of cholinesterase. One of us (J. H. G.) tested its effect on myasthenia gravis in 1943, but had to abandon the work owing to lack of clinical material. This work was continued by the other, and the object of this letter is to report the results.

The drug was injected intramuscularly. In the earlier experiments it was freshly dissolved in water; later, the more stable solution in arachis oil was used. Serum cholinesterase was estimated manometrically using acetylcholine as substrate, and the strength of the muscles controlling the hand was measured with a dynamometer. Neostigmine (prostigmine) had its usual dramatic effects on all these patients. General weakness, ptosis, diplopia and dysphagia disappeared

Type of animal	Dosage of thio-thymine (mgm./kgm.)	White blood cell count in thousands on days										
		1	2	3	4	5	8	9	10	11	12	15
Normal rabbit	20	8·4	6·6	10·6	16·8	16·0	15·5	17·8	19·8	19·8	15·2	21·4
Splenectomized rabbit	100	10·8	12·0	9·6	8·1	7·7	11·3	12·9	13·0	12·7	8·7	10·3

The above figures are the average counts from three rabbits. Injections were given daily from day 3 to day 14.

within about half an hour and returned after two to three hours. The serum cholinesterase activity fell and the readings of the dynamometer rose; these changes occurred at about the same time as the clinical improvement. The injection of di-isopropylfluorophosphonate (0·1–10 mgm.) caused no obvious immediate clinical improvement, but the serum cholinesterase activity fell and the dynamometer readings rose within half an hour, and these changes lasted longer than the corresponding changes after neostigmine.

The absence of clinical improvement in spite of a marked fall in serum cholinesterase in these experiments was interesting but disappointing. It was, however, noticed that dynamometer readings taken at 10 a.m. showed a small rise lasting a number of days after injections of the drug. Experiments were therefore undertaken to test the effect of a daily dose. In three patients, 0·5–2 mgm. was injected once daily for periods up to three months. Neostigmine was also given in the early stages of this treatment. In two cases there was marked clinical improvement after one to two weeks of this treatment, and the daily requirements of neostigmine fell. The dynamometer readings taken 24 hours after the injections showed a marked rise, and the serum cholinesterase was reduced by 86–90 per cent. These patients were eventually discharged from hospital and continued to give themselves 0·5 mgm. per day, and have reported satisfactory progress so far. Atropine was given to counteract the muscarine actions of the di-isopropylfluorophosphonate; but in spite of this, all three patients complained of tightness of the chest, and in one case treatment was abandoned because of this effect.

These results are in general agreement with those of Comroe *et al.*[3].

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Effect of Calciferol and of Penicillin on Experimental Tuberculosis of Guinea Pigs

Among the many points touched upon in recent literature of tuberculosis are: (1) the favourable results in the treatment of lupus, and possibly other forms of surgical tuberculosis, with calciferol[1-3]; (2) the conflicting results reported by various workers[4-6] as to the effect of penicillin. In the course of an extensive experimental study of the chemotherapy of tuberculosis, we have made observations bearing upon these questions which it is thought are of sufficient interest to report briefly.

500-gm. guinea pigs were infected with 0·001 mgm. of human tubercle bacilli (strain *H*.418) intramuscularly, and after four weeks, when all pigs were tuberculin positive, various treatments were commenced and continued for ten weeks. Survivors of all treated groups and of untreated controls were killed and assessed for infection by the method of Sher and Kloeck[7]. Individual and average assessments are given in the accompanying table; survival times were also noted. Streptomycin was taken as an active drug control, but only five animals were killed when this experiment terminated, as previous work had shown that the amount of drug given was enough to suppress the disease during the period of treatment (ten weeks).

Details of drug dosage are as follows:

Penicillin: 500 u. / guinea pig / day subcutaneously in saline given in two doses of 200 and 300 units a.m. and p.m.

Calciferol: 2,000 u. / guinea pig / day in arachis oil given with the food.

Streptomycin: 10,000 u. / guinea pig / day subcutaneously in saline given in two doses of 4,000 and 6,000 units a.m. and p.m.

Group	Deaths	T.B. assessments	Average
Untreated (14)	5/14	71*, 74, 53, 85*, 51 88, 85, 49, 88*, 81* 65, 81,* 84, 85	74·3
Penicillin (11)	8/11	75*, 73*, 71*, 73, 83* 61, 86, 88, 82*, 65* 79*	75·5
Calciferol (12)	5/12	88*, 78*, 69, 98*, 66 68, 76*, 86*, 62, 79 71, 71	76·0
Streptomycin (50)	0/50	5 killed at random 4, 2, 4, 2, 2	2·8

* Asterisk denotes death of animal

It is obvious from the results that there is no difference between the extent of tuberculosis of penicillin-treated, calciferol-treated and control groups.

There was no evidence of toxicity or abnormal calcification in the animal treated with calciferol, nor in a group of normal guinea pigs which received 25,000 units of calciferol a day for ten weeks. These doses roughly correspond to those used in the treatment of lupus vulgaris in man.

I wish to thank Sir Jack Drummond, who suggested the work on calciferol, Mr. C. E. Coulthard, for his interest in these investigations, and Mr. B. H. Chantrill, for help with the *in vivo* work.

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Fibrinolysis in the Animal Organism

It is now known that the action of the fibrinolytic substance produced by certain streptococci is due to its properties as an activator for the transformation of a proenzyme present in blood serum and plasma into a proteolytic enzyme acting on the fibrin. This activation can also be carried out by treatment with chloroform (for references see Christensen[1] and Kaplan[2]). Considerable confusion concerning the nomenclature for the substances interacting in the fibrinolysis exists; but it seems most logical to use the proposal of Loomis, George and Ryder[3]. According to this, the name 'fibrinolysin' is used for the active fibrinolytic enzyme, while the inactive precursor is termed 'profibrinolysin'. The activating principle produced by streptococci, and previously termed fibrinolysin, is called 'streptokinase'. This nomenclature expresses thus the similarity between the system in question and certain other enzyme systems, for example, the formation of trypsin and thrombin.

We have found that profibrinolysin can be transformed into fibrinolysin by an activator contained in animal tissue cells. The occurrence in the animal organism of a process of this type was suggested by Fischer[4].

Ox fibrinogen prepared from Bordet plasma was used. The preparations of ox thrombin contained 10–13 of our thrombin units per mgm.[5,6] (obtained from Løvens Kemiske Fabrik, Copenhagen). All experiments were performed aseptically with sterile solutions.

In a fibrin clot prepared from these solutions, tissue slices from different organs from mammals (ox, pig, rabbit and rat) produced fibrinolysis, the degree of which depended upon the nature of the organ and the species of the animal used. Tissues from chicken and hen were inactive, a fact which is of considerable interest in view of the species specificity disclosed in the proteolytic activity of malignant tissue cells[4]. Streptokinase also was inactive when tested on ox fibrinogen.

Fibrinogen solutions from which the fibrinogen was removed, that is, by heating to 56° for 5 min. or by clotting with thrombin, contained after incubation for 24 hr. with washed tissue fragments at 37° a powerful fibrinolytic enzyme. This indicates the presence of a profibrinolysin in the original fibrinogen solution.

The ability of the tissue to activate profibrinolysin was retained undiminished after several weeks in water containing toluene and chloroform as preservative, and was not dependent on the metabolism of the living cell. It was not found possible to extract the activator from the tissues, but washed suspensions were very active. The activation of fibrinolysin is thus a general property of normal tissue cells. In continuation of the nomenclature mentioned above, we propose to call this activating principle 'fibrinokinase'. The name should really be 'cyto-fibrinokinase', and the activating principle from streptococci should be called 'strepto-fibrinokinase'; fibrinokinase thus being a term for a group of different chemical compounds exhibiting the common property of being able to activate profibrinolysin to form fibrinolysin.

It may be of value to point out the general nature of the principle for producing active substances in the living organism as expressed in the reactions mentioned. Together with the renin-hypertensin system, they represent a type of reactions, in which a tissue component (thrombokinase, renin, fibrinokinase) acts upon a protein circulating in the blood stream (prothrombin, hypertensinogen, profibrinolysin) in order to produce an active substance of high potency (thrombin, hypertensin, fibrinolysin). In addition to the specific inactivating substances present in the blood (antithrombin, hypertensinase, antifibrinolysin), this mechanism serves the organism as a means of regulating the amount of certain substances the formation of which might be dangerous.

A detailed study of the fibrinokinase–fibrinolysin system is being carried out by one of us (P. M. P.), and the results will be published in due course.

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Oriented Movement of Blue-Green Algæ on a Stretched Gel

TROPISTIC and tactic responses to stresses in an elastic substrate have been described for several kinds of biological material. The true bacterium *Kurthia zopfii*, when grown in gelatin subjected to mechanical tension, reflects precisely in its pattern of growth the pattern of stresses in the substrate[1-3]; a similar response is shown by nerve fibres cultivated on stretched coagulated plasma[4]. Jacobsen[1] proposed the name 'elasticotropism' for this type of behaviour. A few years ago, the corresponding tactic response was demonstrated in myxobacteria on stretched agar gels[5]. The effect of elasticotaxis in these organisms is particularly striking through its secondary influence on the fruiting process; the rigidly oriented movement of the vegetative cells causes marked abnormalities in the shape and distributional pattern of the fruiting bodies.

Recently I have observed elasticotactic behaviour in two strains of blue-green Algæ belonging to the family Nostocaceæ, received from Dr. T. Gibson, by whom they were isolated in pure culture. It is easy to follow the movement of these organisms on agar, since motile trichomes leave visible 'tracks' on

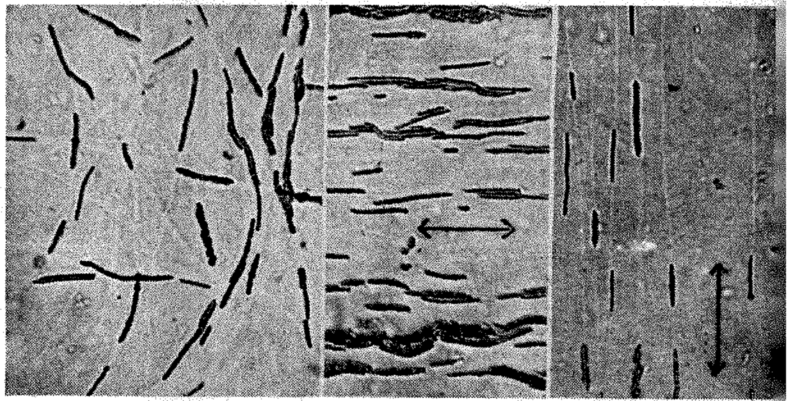
Fig. 1 Fig. 2 Fig. 3

Fig. 1. TYPICAL ARRANGEMENT OF TRICHOMES AND TRACKS ON UNSTRETCHED AGAR

Fig. 2. ORIENTATION OF TRICHOMES ON STRETCHED AGAR. THE ARROW INDICATES THE DIRECTION OF STRESS

Fig. 3. ANOTHER EXAMPLE OF ORIENTATION ON STRETCHED AGAR. THE LINEARITY AND PARALLELISM OF THE TRACKS IS PARTICULARLY CLEAR. THE ARROW INDICATES THE DIRECTION OF STRESS

(Tracks appear as faint light-coloured markings not easily seen in the reproductions.)

the surface of the medium over which they have travelled. When an agar plate is heavily inoculated in one spot and exposed to even illumination, the trichomes creep out evenly from all sides of the inoculum, for the most part following curved paths. Microscopic examination of the agar surface surrounding the inoculum on a plate several days old shows the presence of a large number of randomly oriented trichomes, the areas between them being covered with a network of curved tracks (Fig. 1). However, if the agar is initially subjected to tension (by laying a strip over a glass rod, for example), a markedly different pattern of movement develops. The trichomes move only in straight lines parallel to the applied stress, all migration from the inoculum at right-angles to the stress being prevented. On microscopic examination the trichomes are found to be rigidly oriented with their long axes parallel to the stress, and the tracks appear as a series of beautifully parallel straight lines (Figs. 2 and 3). As the organisms reach areas of decreased tension a certain amount of disorientation makes its appearance, and those trichomes which succeed in reaching a completely unstressed region of the agar regain their liberty of movement, reverting to the normal random orientation and following curved paths. When trichomes pass from an area of tension to one of compression, their orientation changes by 90°. The elasticotactic behaviour of blue-green Algæ is similar in all respects to that of myxobacteria, but the former organisms provide more favourable material for study of the phenomenon, because of their relatively much greater size and their formation of tracks on the substrate.

Since blue-green Algæ and myxobacteria have long been considered to possess similar mechanisms of locomotion, the identity of elasticotactic response in the two groups is not a matter for surprise. It would be interesting to know whether micro-organisms the movement of which on solid surfaces is effected by radically different mechanisms (for example, diatoms and amœboid protists) also respond to this stimulus.

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Genetics of Red Body Colour in *Armadillidium vulgare*

Previous work[1,2] and also many unpublished results have shown that in the woodlouse *Armadillidium vulgare* Latr. red body colour and a colour pattern called type *D* behave as simple autosomal dominants to the common black and grey types (the only complication being that in adult animals type *D* is sex-limited to the female sex). Collinge[3,4,5], however, has reported results which do not agree with mine in that he fails to find any segregations. I was inclined to believe that Collinge's results were due to his scoring animals before they were really old enough for the different colour types to be distinguished; for he had stated[6] that, when he examined some young from the variety *rufobrunneus* (red) at just over three weeks old, no trace of red or brown coloration was apparent, and that, if he had not known their history, he would have identified them as young specimens of the variety *plumbeus* (grey-black). While it must be emphasized that in the majority of cases red colour does behave as a simple dominant, and that one does usually obtain good 1 : 1 and 3 : 1 segregations, I have recently obtained some results which confirm Collinge's observations.

The first unexpected result was brood 223 from the red, type *D* female *GN*, which was collected pregnant from Four Went Ways. This brood consisted of 95 black animals and 0 reds. This, of course, can be explained if we assume that there is a recessive gene for red as well as a dominant. Vandel[7] has, in fact, found recessive red types in *Armadillidium vulgare*. Segregation for type *D* in brood 223 was normal, the 92 females consisting of 48 type *B* (the common female colour pattern) and 44 Type *D*.

The second set of unexpected results started with the red, type *B* female *AU*, also obtained already pregnant from Four Went Ways. Brood 185 from this female consisted of 15 red : 35 black. The animals from this brood were numbered *AUA* to *AUF*, and their breeding behaviour is shown in the table below:

Parents		Brood	Segregation	
Female	Male	number	Red	Black
AUA (red)	Brood 185 red male	212	22	0
AUB (red)	Brood 185 red male	213	30	0
AUB (red)	None since brood 213	240	51	0
AUC (red)	Brood 185 red male	214	18	0
AUC (red)	*CRA* (black)	237	0	3
AUD (red)	Brood 185 red male	215	36	0
AUD (red)	*AYA* (black)	245	0	33
AUE (red)	*FM* (black)	238	0	56
CU (red)	Pregnant when collected	187	15	19
CU (red)	None since brood 187	230	33	52
CU (red)	*AUF* (red)	239	53	0

It will be noticed first that red females from brood 185, mated with their own brothers, produce broods consisting of red animals only, and secondly that the same females when mated with unrelated black males produce broods consisting of black animals only. Both these facts would fit the hypothesis that the red colour of female *AU* and her offspring was due to a recessive gene. This explanation, however, probably breaks down when we consider brood 239. Female *CU* was obtained from the Cambridge University Farm, and all other red animals from this locality have always been dominant reds. The segregations in broods 187 and 230 are thus probably due to female *CU* being heterozygous for dominant red and to her having mated with a common black male. If this is so, then male *AUF* appears to be homozygous for dominant red and not for recessive red.

The true explanation of the above results is not yet known, and it is obvious that one easy test, namely, to inbreed black animals from broods 185, 238 and 245, remains to be done. On the other hand, the results may not be explainable on normal Mendelian lines, since it is already known[1,2,8] that sex ratios in *Armadillidium* and other woodlice are peculiar. It is also interesting to note that the Four Went Ways population is peculiar in containing quite a number of intersexes, including the one described by Collinge[9].

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AMERICAN AWARDS TO BRITISH MEN OF SCIENCE

THE Medal for Merit, which has its origin in an order by President Washington, is the highest award made by the Government of the United States to a civilian. We print below the names of British men of science recently awarded the Medal, with the accompanying citations:

Sir Edward Appleton, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Sir Edward, as secretary of the Department of Scientific and Industrial Research and chairman of the British National Committee for Radio Telegraphy, organised and supported scientific workers, prosecuting many of the important scientific projects which resulted in Allied supremacy. He was outstanding in the effectiveness of his work for co-operation between British and American scientists, and was responsible for important phases of the early research leading to the development in England and the United States of modern radar.

Prof. P. M. S. Blackett, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Prof. Blackett, a British pioneer in the field of operational research, not only played a decisive role in the scientific war activities of his own country, but his inspiring leadership stimulated developments in the United States similar to those initiated by him in Great Britain. His brilliant analysis and interpretation of operation data was a major factor leading to the Allied success in the anti-submarine campaign. The value of his work to the United States was outstanding, and his advice and counsel to us were invaluable contributions to the war effort.

Dr. Robert Cockburn, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Dr. Cockburn, as head of the Counter-measures Group of the Telecommunications Research Establishment in the Ministry of Aircraft Production, was instrumental in devising new electronic techniques to counter the enemy's use of fire control methods, navigation aids and bombing devices. He was one who early appreciated the high importance of electronic intelligence, and devised equipment and analytical methods to seek out this intelligence. He exerted himself to provide for co-operation between British and American scientists. In the field of radio and radar counter-measures, Dr. Cockburn was the British scientist who above all others had the most comprehensive grasp of the scientific and operational problems involved.

Mr. A. P. Rowe, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Mr. Rowe, as head of the great Telecommunications Research Laboratory of the Ministry of Aircraft Production throughout the War, and himself a stimulating and energetic leader of men, exercised a dominant role in the development of radar and counter-measures in the United Kingdom. When American scientists working in these fields proposed to establish advanced laboratories in England, he co-operated enthusiastically, opening his own establishment for their equal use. The inter-Allied discussions at the Telecommunications Research Establishment were famous for their frankness and stimulation. Co-operation was strenuously advocated by him; and in the development and employment of electronics in warfare Mr. Rowe made important contribution.

Sir Reginald Stradling, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Sir Reginald, as chief adviser on research and experiments to the Ministry of Home Security from 1940 throughout the War, conceived and directed the far-flung British experiments and observations of the effects of bombs. His revolutionary work led to data of vital importance in the air war with Germany. He pioneered in the measurement of blast, which materially affected the entire study of explosive effects culminating with the atomic bomb. He freely made available to the United States the information and resources at his command. He welcomed and trained many young Americans at his Princes Risborough Station in the techniques he had discovered. Sir Reginald's contributions were of invaluable aid to the Allies in time of great peril.

Sir Geoffrey Taylor, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Sir Geoffrey's researches during the War exercised a notable influence on American investigations. His inquiring intellect penetrated into the depths and brought up certain knowledge. He established fundamental truths in fluid dynamics and gas dynamics. He gave inspiration and direction to research in shock-wave propagation, detonation and underwater explosion. His work will continue to influence scientific development, and his contributions were of inestimable value to the war effort.

Sir Henry Tizard, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. Sir Henry, as leader of the British Technical Mission to the United States in 1940, initiated Anglo-American scientific relations, concluding arrangements for the interchange of information relating to the development of devices for warfare. Later, as scientific advisor to the Air Ministry and member of the Council of the Minister of Aircraft Production, he was a central figure in assuring that research and development as well as operational information of high value in the solution of American problems of aerial warfare, be made available to the United States. Of brilliant mind, gifted with wide imagination, Sir Henry's contribution to the scientific effort of the War was unique.

Sir Robert Watson-Watt, for exceptionally meritorious conduct in the performance of outstanding services to the United Nations. An outstanding authority on radar, Sir Robert's years of work, in a field little frequented, largely formed the basis of the extraordinary early success of British radar when the onset of the War engulfed England in a wave of bombing. His keen technical foresight and ability to organise, with his understanding of human nature, were capitalized in the 'Battle for Britain'. The success attained in the military employment of these new scientific devices and methods inspired and stimulated the great radar programme in the United States. He collaborated in every way with American research groups. In the development and effective combat employment of superior types of radar, radar counter-measures and communications equipment, Sir Robert's services were of enormous value.

LINEN INDUSTRY RESEARCH ASSOCIATION

ANNUAL REPORT

THE report of the Council of the Linen Industry Research Association (from the Association, Lisburn, Northern Ireland) for the year ended September 30, 1946, records that the whole of the inen industry and trade in Northern Ireland are now members of the Association, which has thus become fully representative on a purely voluntary basis. The rate of subscription paid by each individual member has also substantially increased, and the Association has qualified for the maximum possible grants from the Department of Scientific and Industrial Research and the Government of Northern Ireland. Some additions have already been made, to the staff, but in building up a strong, well-qualified body of workers, the Association is in competition with other demands for the limited number of new science graduates available. A good proportion of the Association's staff is trained by the Association, and during the year the value of the Association's scholarship open to first-class honours graduates in science of the Queen's University, Belfast, was considerably increased. Plans have been considered for a new technological building, but this is not expected to be completed for some time.

In pursuance of the new arrangements for keeping members in touch with the latest developments at he Institute, heads of departments are now visiting the individual Scottish members of their section wice yearly. The director and head of the Chemistry Department were members of the linen industry nvestigating mission in Germany during June–July 1946, and the director of research is also a member of the Flax Committee and chairman of its Flax Utilization Sub-Committee. Referring to the large reduction in acreage under flax in Northern Ireland n 1945 and 1946, the Council in its report emphasizes the urgency of research in making the growing of flax more economical in view of this increased dependence on foreign supplies of flax.

Research work noted in the report includes the statistical analysis of records of soil conditions and yields of crops, seed and fibre during 1941–44; studies to determine the effect of time of pulling on retting behaviour and on yield and quality of fibre, and spinning tests of lots of flax from the 1944 crops. An attempt has been made to devise a more objective est than the usual pull-off test for determining the end-point of retting, and an investigation of the causes of low yields with turbine scutching machines has shown that improved yields may be obtained by suitable pre-breaking and proper positioning of the strip by the feed on the conveyor belt and by modification of the beaters. The fifty per cent average loss of efficiency of clean fibre extraction is attributed o factors causing breakage of the fibre strands or straw. Data obtained in an investigation of the relation between fibre qualities and yarn quality have already thrown light on important technical problems.

The hot-air drying of flax yarn in hank form and he levelness of rayon staple yarns spun on flax machinery have also been investigated. Weaving esearch has centred on the performance of warp top motions on looms, modifications to looms and methods of weaving to reduce warp breaks and improve cloth quality, and efficiency surveys in factories.

Work on dyeing and bleaching has aimed at increasing efficiency and improving quality, and particularly at securing the maximum fastness to laundering. In finishing studies, particular attention has been directed to crease-resistant treatments, and work on the proofing of canvas fabrics against attack by various agencies has continued.

ANTIBIOTIC ACTION OF AN EXTRACT OF *GALLERIA MELLONELLA**

By Prof. H. R. OLIVIER

LARVÆ of *Galleria mellonella* are selected in their adult state a little before they begin to form their cocoons. Ground up and the chitinous cuticle filtered off, they are extracted with acetone. This extract is washed three times with $N/10$ sodium hydroxide. The three liquors thus obtained are freed of acetone, neutralized to pH 7·5, and each is concentrated so that 1 c.c. corresponds to 1 gm. of larval bodies.

Tubes containing 10 c.c. of glycerinated veal broth are then inoculated with 0·1 c.c. of a four-day culture of the homogeneous tubercle bacillus of Arloing and Courmont, and to these are added increasing quantities of the extracts of *Galleria mellonella*. The accompanying table shows one of our experiments, the dosages I, II and III representing the successive extractions of the original acetone extract.

	Date	4th	6th	8th	10th	12th	Lysis experiment
	Control	++	++	++	++	++	
I	0·05 c.c.	+−	++	++	++	++	Bacilli of normal aspect
	0·1 c.c.	−	+−	+	+	+	
	0·5 c.c.	−	−	+	+	+	
	1·0 c.c.	−	−	−	−	−	
II	0·01 c.c.	+	++	++	++	++	Bacilli of normal aspect
	0·1 c.c.	+−	+	+	++	++	
	0·5 c.c.	+−	+−	+−	+−	+−	
III	0·01 c.c.	Subtilis					Bacilli clumped, badly staining, and of ill-defined contour
	0·1 c.c.	−	−	+	+	+	
	0·5 c.c.	−	−	Subtilis			

In all our experiments the extracts have begun to show activity at a dosage of 0·1 c.c. If, by analogy with our experiments with 'Endosubtilysine', this is taken as a unit of activity, our extract has an action against the bacillus of Arloing and Courmont corresponding to 30 units per gm. of larval bodies.

We then added to 2 c.c. of a homogeneous culture of the bacillus of Arloing and Courmont, five days old, 1 c.c. of each of the three alkaline liquors I, II and III. After forty-eight hours incubation the mixtures were centrifuged and the deposit stained by the Ziehl method and examined. The bacilli were greatly altered by liquor III, staining badly, and being thickened and ill-defined in contour.

Conclusions. The larvæ of *Galleria mellonella* contain a substance extractable with acetone and possessing an antibiotic action against the homogeneous tubercle bacillus of Arloing and Courmont. In high concentration the extract appears to produce lysis in the same organism.

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* Translated by Dr. James Marshall.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, May 20

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. H. J. Eysenck: "Measurement of Socially Valuable Qualities".*

University College (at Gower Street, London, W.C.1), at 5.30 p.m. —Dr. E. J. Holmyard: "History of Chemistry in Islam" (another lecture on May 23).*

Wednesday, May 21

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Prof. O. G. Sutton: "The Problem of Diffusion in the Lower Atmosphere"; Mr. W. G. V. Balchin: "A Microclimatological Investigation of Bath and the Surrounding District".

Royal Society of Medicine, Endocrinology Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "New Aspects of Insulin Action" (to be opened by Prof. F. G. Young (biochemical aspects), and Dr. R. D. Lawrence (clinical aspects)).

Royal Microscopical Society (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Discussion on the Programme of the Scientific Film Panel, and an Exhibition of Films.

Institute of Metals (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Sir Wallace Akers: "Metallurgical Problems involved in the Generation of Useful Power from Atomic Energy" (Thirty-seventh May Lecture).

Thursday, May 22

Chadwick Public Lecture (at the Town Hall, Cheltenham), at 3 p.m.—Sir Arthur MacNalty, K.C.B.: "Advances in Preventive Medicine during the War of 1939–45".*

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. H. Jeffreys, F.R.S.: "Probability".

Mineralogical Society (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. S. Tolansky: "An Interferometric Survey of Mica".*

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. R. M. Shone: "The Iron and Steel Development Plan—some Statistical Considerations".

Friday, May 23

Society of Chemical Industry, Food Group (joint meeting with the Birmingham and Midland Section, at the Birmingham Chamber of Commerce, New Street, Birmingham), at 2.30 p.m.—Discussion on "Trade Wastes" (Dr. B. A. Southgate: "Effects of Polluting Discharges"; Dr. S. H. Jenkins: "Principles of Trade Waste Treatment").

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion of Geophysical Papers.

Sunday, May 25

Society for Visiting Scientists, the Association of Scientific Workers and the World Federation of Scientific Workers (at the Beaver Hall, Garlick Hill, London, E.C.4), at 7.45 p.m.—Meeting in Memory of Paul Langevin.*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physical Chemistry, a Lecturer in Pharmaceutical Chemistry, a Lecturer in Metallurgy, a Lecturer in Physics, and a Lecturer in Biology—The Registrar, College of Technology, The Newarke, Leicester (May 24).

Scientific Assistants (women) in the Soil Chemistry Department, East African Agricultural Research Station, Amani, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, 15 Victoria Street, London, S.W.1 (May 24).

Lecturer in Chemistry and Metallurgy—The Registrar, Technical College, Sunderland (May 24).

Lecturer in Mathematics—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (May 24).

Senior Research Chemist—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (May 24).

Lecturer in Organic Chemistry at the Coventry Technical College—The Director of Education, Council House, Coventry (May 24).

Research Biologist to work in a team studying Plankton Ecology in relation to the Fisheries—The Registrar, University College, Hull (May 24).

Editorial Officer—The Hon. Secretary, Society of Dyers and Colourists, 32–34 Piccadilly, Bradford, endorsed 'Editorial Officer' (May 24).

Senior Assistant in the Department of Metallurgy—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (May 24).

Senior Assistant Lecturer in Mechanical Engineering up to Higher National Certificate standard—The Principal, Handsworth Technical College, Golds Hill Road, Handsworth, Birmingham 21 (May 24).

Senior Assistant for Electrical Engineering, and a Teacher in Mechanical Engineering subjects—The Principal, Municipal Technical College, Hopwood Lane, Halifax (May 24).

Lecturer in Mechanical Engineering subjects in the Ipswich School of Technology—The Chief Education Officer, Education Department, 17 Tower Street, Ipswich (May 24).

Head of the Department of Physics, Mathematics and Navigation, Plymouth Technical College—The Director of Education, Education Office, Coburg Street, Plymouth (May 24).

Assistant Lecturer (Grade III) in the Department of Philosophy—The Registrar, The University, Liverpool (May 30).

Science Editor—The Director, Appointments Department, British Council, 3 Hanover Street, London, W.1 (May 30).

Chief Statistical Officer to the Ministry of National Insurance—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1877 (May 31).

Research Scholarship in Vertebrate Zoology—The Registrar, The University, Bristol 8 (June 1).

Chemists (men and women) as Assistant Experimental Officers at the Ministry of Supply Atomic Energy Centre near Preston—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.339/47A (June 4).

Chemists (women) in the Scientific and Experimental Officer Classes at the Ministry of Supply Atomic Energy Centre near Preston—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.330/47A (June 4).

Professor of Electrical Technology at the Indian Institute of Science, Bangalore—The High Commissioner for India, Genera Department, India House, Aldwych, London, W.C.2 (June 7).

Senior Organic Chemist in the Biochemistry Section for work on the organic constituents of fruit-bearing plants—The Secretary, East Malling Research Station, East Malling, Kent (June 7).

Animal Husbandry Officers (2) in the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office o the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (June 7).

Research Officer, Timber Preservation Section, Division o Forest Products, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1187 (June 9).

Lecturer in the Department of Social Studies, and an Assistant Tutor in Practical Social Work—The Registrar, The University, Leeds 2 (June 9).

Readership in Applied Mechanics at the Imperial College o Science and Technology—The Academic Registrar, University o London, Senate House, London, W.C.1 (June 12).

Principal Scientific Officer at the Armament Design Department of the Ministry of Supply, Fort Halstead, Kent—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1871 (June 14).

Principal Scientific Officer at the Telecommunications Research Establishment of the Ministry of Supply, Malvern Worcs.—The Secretary, Civil Service Commission, 6 Burlington Gardens London, W.1, quoting No. 1870 (June 14).

Professor of Mining—The Registrar, University College, Nottingham.

Meteorological Assistants (both sexes)—The Under-Secretary of State, Air Ministry (S.2b), Cornwall House, Stamford Street London, S.E.1.

Lecturers (3) for Mechanical Engineering subjects to the Higher National Certificate and University Degree standard, and a Lecturer in Physics to London University special degree standard—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

Technician in charge of the new Clinical Photographic Department—G. Hurford, Queen Elizabeth Hospital, Birmingham 15.

Laboratory Technician—The Medical Superintendent, Notts County Mental Hospital, Radcliffe-on-Trent, Notts.

Instrument Research Officer, and an Experimental Office for testing dairy plant and equipment—The Secretary, Nationa Institute for Research in Dairying, Shinfield, Reading.

Senior Laboratory Steward for Science Department—Th Principal, County Technical College, Essex Road, Dartford.

Lecturer and Demonstrator in Agricultural Chemistry—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

Lecturer in Chemistry—The Clerk to the Governors of th Technical College, Education Offices, North Street, Wolverhampto

Physical Chemist for work in connexion with Steelmaking, Slag and Refractories—The Personnel Officer, British Iron and Ste Research Association, 11 Park Lane, London, W.1, quoting 'Refractories Section'.

Physicist to work mainly on the physical properties of leathe rubber, plastics and other shoe materials, and a Statistical Mathematician to work on foot measurement surveys of the population—The Director, British Boot, Shoe, and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

Lecturer or Assistant Professor in the Department o Biochemistry—The Professor of Biochemistry, Faculty of Medicin University of Manitoba, Winnipeg, Canada.

Laboratory Steward (Grade IIA) for Organic Chemistry—The Registrar, The University, Leeds 2.

Senior Assistant in the Department of Civil and Mechanica Engineering to teach Advanced Theory and Design of Structur and Surveying, a Senior Assistant in the Department of Chemistry to teach Physical Chemistry to Final B.Sc. (special) Degr standard, and a Lecturer in Chemistry to teach Organic Chemistr to Final B.Sc. (special) Degree—The Principal, Technical Colleg Queen Street South, Huddersfield.

Senior Assistant in Mechanical or Civil Engineering, Lecturer in Mechanical Engineering subjects, a Lecturer Electrical Engineering subjects, and a Senior Laborator Steward in the Chemistry and Biology Department—Th Registrar, Municipal College, Portsmouth.

Lecturer (graduate) in Chemistry in the St. Helens Municip Technical College—The Director of Education, Education Offic St. Helens.

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RESEARCH ASSOCIATIONS AND INDUSTRY

THE Board of Trade Working Party for the Linoleum and Felt Base Industry*, which included as independent members Dr. L. T. M. Gray and Prof. J. Read, leaves no room for doubt as to the importance of scientific research to that industry. The main and over-riding shortage in the industry at present is linseed oil, the supply of which has been cut to thirty per cent of the pre-war supply. This shortage is closely bound up with the world shortage of edible oils and fats, and no substantial improvement in the supplies of linseed oil for the industry is likely this year. Various substitutes for linseed oil have been tried, notably an adipic ester of trimethylolpropane in Germany, and the Working Party recommends that the industry should continue vigorous research on possible substitutes for linseed oil.

This position alone establishes the importance of scientific research to the development of the industry, even from the point of view of the supply of raw materials. While it is clear that the Government could do something more to help the industry by the provision, as the Working Party suggests, of regular information as to the short- and long-term prospects of supplies of linseed oil in view of the possible greater expense of linseed oil substitutes and the modifications to plant which may be involved, and by no longer insisting on a reduction in the allocation of linseed oil in exchange for supplies of substitute materials, the industry does not seem to be doing all that it might to help itself. A total expenditure of only £46,650 on research by nine out of the fourteen firms represents only 0·5 per cent of the turnover, and of these firms two spent an average of more than £5,000 on research during the five years 1936–39 and 1945, while three others spent between £1,000 and £3,000.

When all allowance is made for variations in size of the firms, the figures certainly suggest that several firms have not yet recognized sufficiently the need for research in an industry the future of which may well depend largely on developments in plastic materials. Linoleum itself, as the Working Party notes, is based on a form of plastic material. Further, the processes of the manufacture of linoleum are dominated by chemical changes, which are imperfectly understood. Further research might well lead to far-reaching economies in manufacturing processes, either in the use of power, as the Working Party suggests, or through the utilization of new raw materials to meet the shortage of linseed oil which, as already noted, is likely to persist for some years.

From the point of view of research, the first impression made by this report is the dynamic character of the industry to-day. It is a section of the organic chemical industry, and shares the characteristics, hazards and opportunities of that industry. Its prosperity and development may well be expected to depend on the same factors that have contributed to the development of chemical industry in general in Great Britain. Any special pleading on behalf of the linoleum industry should accordingly be excluded *a priori*, nor does the Working Party appear to advance such pleading. On the contrary, it suggests that the industry, which is too small to carry its own central research organisation, should make more use of the existing research organisations. Reference is made, in particular, to the Paint Research Station, though it is probable that the National Chemical Research Laboratory could also be of service.

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* Board of Trade. Working Party Reports: Linoleum and Felt Base. Pp. viii+49. (London: H.M. Stationery Office, 1947.) 1*s*. 6*d*. net.

Dr. J. L. Simonsen assisted Prof. Read in visiting the Paint Research Station at Teddington and reporting on the suitability of that station as a research centre for the industry. The sub-committee was very favourably impressed by the quantity and range of the work now being conducted in the Paint Research Laboratory, and considers that the Laboratory offers a valuable nucleus of buildings, equipment and staff which could be expanded with great benefit to the linoleum and felt base industry. It is suggested that, as a first step, the Paint Research Station should develop a special section to take up long-term researches with a direct bearing on linoleum and felt base. This would involve a high priority for building the expansion of the Paint Research Station's premises which is already projected, and it also implies membership of the Paint Research Association by all linoleum and felt base manufacturers, who would thus make an adequate contribution to the research association, earning in turn the usual grant from the Department of Scientific and Industrial Research.

On this proposal there are two comments to be made. The majority of the firms engaged in the manufacture of linoleum and felt base are located in the Dundee or Fife neighbourhood, and are accordingly remote from the Paint Research Station at Teddington. This disadvantage can be exaggerated, but there is this much substance in the proposals from the Scottish Reconstruction Committee, echoed at the recent Scottish Regional Conference of the Federation of British Industries, for the establishment of a Scottish Department, that the Department of Scientific and Industrial Research has in the past tended to overlook the value of the geographical proximity of a research station to the industry it serves primarily. Such proximity is of particular importance for a research association in that it helps to overcome the technical isolation in which the association must work as compared with the research department of an industrial firm.

The proposal to establish a coal utilization research station in the south of England and not on one of the coalfields is a striking example of the Department's failure to appreciate the importance of this factor. While such departmental neglect affords no warrant for such fantastic proposals as the duplication of the Department of Scientific and Industrial Research in Scotland, it does lend some support to the alternative proposal ventilated by Dr. R. Hay at the Federation of British Industries Conference and hinted at rather than advanced in the present report. If the establishment of a separate institute for long-term research relating to the linoleum and felt base industry is scarcely justified, the endowment of one or more industrial fellowships for the purpose at an institute of the type of the Mellon Institute located within easy reach of the main manufacturing area might be an equally or more effective measure than the development of a special section at the Paint Research Station at Teddington.

The admirable report which has since come from the Working Party for the Wool Industry* contains a proposal which bears on this suggestion. Discussing the special problems of the industry in Scotland, it is proposed that the production centre to be developed in connexion with the Scottish Woollen Technical College at Galashiels should be linked with a design centre and a research centre, thus providing a first-rate educational centre for all matters relating to the woollen industry. Fundamental research would continue to be confined to the existing research centres at the University of Leeds and Torridon; but it is suggested that many problems, particularly in mill organisation, machinery, materials and processes, could be dealt with at Galashiels, and that a research section there would stimulate firms to a realization of the problems lying around them, with the solution of which technical advances may be made.

Attractive as such a suggestion may appear at first sight, particularly in relation to technical education and the fostering of research at technical colleges, it will require very careful examination both in regard to its effect on the existing research association and in relation to the alternative idea of endowing fellowships at a Scottish institution of the type of the Mellon Institute. In the first place, apart from the present stringency of resources for research, both in materials and equipment as well as in man-power, there is real danger of dissipating our effort in relatively ineffective or inefficient undertakings. Elsewhere in its report, the Working Party records its conviction that the funds available for research in the industry have been quite inadequate, and that the present unsatisfactory relations that exist between the Textile Department of the University of Leeds and the Wool Industries Research Association at Torridon, and between these institutions, the technical colleges and the firms themselves, would be largely remedied by increased expenditure on research.

In the second place, it may be observed that the outlook in the industry, as disclosed in this report, does not encourage much optimism as to the local support which would be forthcoming for a new research centre at Galashiels. It is suggested that this research centre will serve to meet the needs of the smaller firms who do not employ physicists or chemists; but this argument overlooks the fundamental factor that it is the absence of technical men in these firms which is responsible for the unsatisfactory attitude to research and for the inability to apply the results of scientific advance. The attitude of many supporters of the Association at Torridon, quoted in the report, who, recognizing the high value of the discoveries made at the University of Leeds, argue that such results are of equal value to their competitors

* Board of Trade. Working Party Reports: Wool. Pp. vii+232. (London: H. M. Stationery Office, 1947.) 3s. 6d. net.

and object to the publication to the world of the results for which they subscribe for their own special use, indicates that a real change of atmosphere as well as close co-ordination is required. Furthermore, just as with the linoleum and felt base industry, many of the problems calling for research, such as dyeing problems, raw materials and machinery, and the use of substitutes, involve links with other branches of industry and can profitably be investigated by co-operative effort between industries.

That in itself is an argument for trying the idea of the industrial fellowship at an institute of the type of the Mellon Institute, and indeed indicates the character of the problems which should be referred to any such institute. Meanwhile, the Working Party has made out a convincing case for an advisory research council, even if its recommendation that the time has come for the textile industries to pool their ideas on research and set up a national textile research council for the whole of the textile industries is more debatable. The Working Party does not suggest that the joint advisory wool textile research council which it proposes should concern itself with the details of investigations; but it would be charged with the duty of arranging that the respective types of investigation cover the necessary ground, it should eliminate undue overlap, and encourage friendly co-operation. One of the principal tasks of the proposed council would be to deal with the problem of secrecy, which appears to be such a bugbear in the industry.

The Working Party suggests that the Department of Scientific and Industrial Research or other Government authority should invite representatives of universities, the technical colleges, the Wool Industries Research Association, the employers, trade unions and some independent persons to meet to establish such a council. Meanwhile, it expresses complete approval of the application of the Wool Textile Delegation to the Board of Trade for a statutory evy to raise £150,000 for general research purposes, of which £100,000 would be assigned for scientific research and the rest for market research. It suggests, however, that up to 25 per cent of the first sum should o to meet the needs of universities and technical colleges engaged in textile research, and that this amount would be administered by the proposed esearch council, which should also be responsible for administering on the same lines the sum of £100,000, which should be set aside from the export levy for he promotion of research.

The Working Party, in making these proposals, hows the same wide outlook as the Working Party for the Cotton Industry did in its report last year. he main proposal involves the use of the proceeds of a statutory wool levy for purposes that include development of other fibres, and it is recommended that the proposed research council should invite other industries to co-operate in such research and o contribute to its cost. Like the Cotton Working Party again, it is impressed with the need for undamental research in the design of textile machinery, and suggests that the textile machinery-making industry should set on foot a textile machinery research association to work in close alliance with the existing research associations of the textile trades. Similarly, close liaison should be established with existing research and development institutions concerned with problems of fuel and power, to promote increased efficiency, convenience and cleanliness. It is also recommended that the present tendency towards development work as joint efforts of research centres and individual firms should be fostered. The Research Association should have at its disposal greater facilities for the experimental testing of suggestions for general experimental work on production problems, either in the form of development units or other plant in suitable premises. The present buildings at Torridon are condemned as unsuitable, and erection of a new research station as soon as possible on a much more comprehensive scale and in a central position is recommended.

These proposals show that, while critical of the Woollen Industries Research Association, the Working Party is agreed that it should be continued, and that it should receive fuller support, both financially and in other ways. For this reason the comments under the heading "Liaison and Information" are instructive. True appreciation of the spirit, meaning and implications of research is still, in the view of the Working Party, disappointingly low both among the general public and in the wool industry; and often people in responsible positions, who subscribe freely to the Research Association, have only the vaguest idea of the method and significance of what is being done. Many of the findings of research are failing to penetrate into the very places where they are needed, mainly because the language and technique of communication are inadequate.

The Working Party recognizes that only a rise in the general standard of textile education will permit a satisfactory solution, and that the trade press, which is the normal agency through which new knowledge reaches the industry, must carry a considerable share of responsibility. It also welcomes the new Department of Scientific and Technical Liaison now being set up by the International Wool Secretariat, and it is implicit in the report that the Research Association itself should give more attention to the efficiency of its liaison and information services.

Even more important, however, than the emphais of this report on the co-ordination of relations between existing research institutions is the attention directed to the true functions of a research association. Not even the report of the Cotton Working Party is calculated to stimulate more fundamental thinking about this question, and in view of Prof. Polanyi's plea at the recent British Association conference in Manchester, it is interesting to note how firmly this report insists with him that the university research departments are the chief sources and true homes of fundamental research. The main nourishment of the research associations, as of industrial research in general, must thus come from the scientific work of the universities; but the university research departments in turn will profit from adequate contact with industry, whether or not that is made through research associations.

The first function of the research association, in the view of the Wool Working Party, is to seek in its appropriate industry the broad problems and processes involved, and to submit them to careful scrutiny in the light of the best scientific knowledge available. Its second main function is to see that fundamental advances take the quickest possible path to industrial practice. To discharge these functions it is suggested that the Research Association must carry out some fundamental research of its own as well as investigate *ad hoc* problems submitted by its member firms. But the Working Party does not proceed to discuss the questions that naturally arise out of this: the nature rather than the volume of fundamental research appropriate for a research association; and the effectiveness of its *ad hoc* investigations as compared with those made by the research department of an industrial firm.

These, however, are the questions that require examination before there is any large-scale expansion of the research association movement or any decision as to its future. Further, the Wool Working Party recognizes that no amount of work by a research association can be a substitute for actual participation in research by individual firms. Meanwhile, the observations in this report on the position of textile research at the University of Leeds underlines all that was urged at the British Association Conference in Manchester regarding the endowment of university research and the importance of full freedom of investigation. Any attempt to co-ordinate all fibre studies, wherever carried out, through the establishment of a National Textile Research Council, working in close collaboration with the Textile Institute and the Society of Dyers and Colourists, as proposed in this report, cannot but lead to the study of these questions at the outset, and may in doing so render a real contribution to that overdue, factual and impartial appraisal of the position of the whole research association movement in Great Britain.

There is much in these two reports which deserves the close attention of scientific workers, from both the industrial and the academic point of view; and if the productive efficiency of Great Britain is to be raised to its appropriate level, the general and fundamental problems which they indicate in regard to the organisation of our research effort should be frankly faced, and waste of scientific effort and man-power avoided. Important as is this aspect, however, there should not be overlooked those questions of human relations which are also brought out, and the contribution which science can make in this field also. In the proposals for a joint advisory council, interrelated with like bodies for other major industries in the field of textiles, we see a tentative approach to the elaboration of a new form of industrial democracy, which by promoting fuller understanding between employers and employed in the attack on common problems, may help to solve that basic problem in the raising of the standard of efficiency and output of British industry as a whole—the creation of an atmosphere of mutual confidence, goodwill and common purpose.

ELECTROCHEMISTRY OF RADIOACTIVE SUBSTANCES

Électrochimie des substances radioactives et des solutions extrêmement diluées

Par M. Haïssinsky. (Radioactivité exposés publiés sous la direction de Prof. A. Debierne, 2.) (Actualités scientifiques et industrielles, 1009.) Pp. 68. (Paris: Masson et Cie., 1946.) 125 francs.

THIS short book by an authority on the subject is very welcome at the present time, when the supply of artificial radio-elements is on the verge of abundance. *Inter alia*, the preparation of radioactive sources must shortly become a routine operation in many fields of research, and, for this, electrochemical methods are often superior to all others in convenience, and in the purity and homogeneity of the product.

Introductory and descriptive in nature, the first three chapters deal successively, in general terms and from a practical point of view, with the chemistry of the radio-elements, with their electrochemistry (the phenomenon of spontaneous deposition, leading them to true electrolysis), and with technical details of apparatus and methods.

The fourth chapter, perhaps the most important one, discusses, on theoretical grounds, the formation of extremely thin electrolytic deposits. To account for previously observed facts, Herzfeld had modified the Nernst equation to deal with those cases where quantities insufficient to form even a monatomic layer are deposited; in so doing, however, his equation led to some conclusions which experimentally could not be verified. By the assumption of active centres, where deposition preferentially occurs, Haïssinsky argues that the Nernst equation does hold in extremely dilute solution, in the earliest stages of deposition, and shows that this is not necessarily in disagreement with Herzfeld's modification. It is unfortunate that there should still be uncertainty as to the applicability of the Nernst equation at concentrations of the order of 10^{-12} N. The earlier work of Hevesy and Paneth, Wertenstein, and Joliot using polonium in a rather narrow concentration range (10^{-8}–10^{-11} N), gave no unambiguous Nernst shift with concentration. Later work by Haïssinsky[1] with active isotopes of bismuth, in the rang 10^{-5}–10^{-12} N, indicated that such a Nernst shift doe occur, and on this he bases the affirmation of p. 26 Recently declassified work by H. G. Heal[2], however using polonium, in concentrations of 8×10^{-13} and 10^{-13} N, gives a deposition potential of still $+ 0{\cdot}6$ volt, and he denies the applicability of the equatio at these concentrations.

Part of the difficulty lies, as Haïssinsky points ou later (p. 47), in the use of elements of high valenc (for polonium, a 100-fold concentration change pro duces a calculated potential change of only 0·028 vol —less than experimental differences in measurement on the same solution). Also, the tendency of poloniu to form complexes with the great excess of anion present may obscure interpretation of results obtaine with this element. It is to be hoped that the unce tainty may soon be eliminated, perhaps by the u of a radio-element of lower valency, the electr chemistry of which is already well known (f example, radio-silver).

From the theoretical discussion, the author turn to the electrochemistry of the elements of the natur radioactive series. This, as a summary of practic work, chiefly on the electrolytic deposition of t individual elements of the series from solution and the fused state, should be of great assistance to those wishing to prepare sources for radiochemical, physical, and biological use. A discussion of artificial radioelements and their electrochemical properties—a section necessarily short because of recent conditions—concludes this valuable book. F. MORGAN

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[1] *J. chim. Phys.*, 32, 116 (1935).

[2] National Research Council of Canada. Montreal Laboratory Report MC.33.

EMBRYOLOGY FOR MEDICAL STUDENTS

Human Embryology

By Prof. Bradley M. Patten. Pp. xv + 776. (London: J. and A. Churchill, Ltd., 1946.) 45*s*.

LITTLE more than a year ago a new English text-book of human embryology had a somewhat mixed reception in these columns[1]. Criticisms were that it did not refer to the work of certain British men of science; that a few features in some diagrams were incorrectly labelled; and that here and there the text could have been expanded to advantage. To-day another text-book with precisely the same title is addressed to medical students by Prof. Patten, a well-known and much esteemed American embryologist. It is slightly longer; slightly more lavishly, if not as well (although this is largely a matter of taste), illustrated; it covers almost the same ground; and doubtlessly it is open to some of the same criticism. It would be surprising if it were otherwise. In a subject like topographical embryology, where ideas on the genesis of organs represent dynamic concepts based on successive 'still' views of developmental processes, there is ample opportunity for differences in individual interpretation and emphasis; and furthermore, so much scope that no one person could be expected to have a first-hand knowledge of every part of the whole field.

The purpose of Prof. Patten's book is to present to the medical student a conspectus of human morphogenesis. In this, like the English volume it follows, it succeeds admirably. If either were mastered the student would know far more about general embryology than a very high proportion of lecturers and demonstrators in British anatomical departments to-day—and by the same token very much more than his clinical teachers. No doubt undergraduates are already trying to do this, for the book of a year ago is already sold out, and this is almost certain to be the fate of Prof. Patten's very readable addition to the literature of embryology.

The very fact that this is so makes one ask whether it is right to expect the average medical student to attempt as much as is covered by Prof. Patten. Prof. Patten recognizes that the medical curriculum is overcrowded, and the consequent necessity to confine his book to a 'reasonable compass'. Anatomists who have specialized in embryology may agree with him that seven hundred pages of text is a reasonable compass; and others will as cordially argue that it is far too much. The difficulty here is that, to the man who has not made organogenesis a speciality, the case for devoting to the subject a large part of the anatomical curriculum often appears much overdone—and indeed at times pressed out of the bounds of all practical possibility. Protagonists of embryology offer the excuse that the subject helps to rationalize the topographical detail of anatomy; to understand the basis of the occasional abnormality met with in clinical practice; to appreciate certain of the problems of obstetrics; and above all, that it has a major intellectual or cultural value. Item by item few would bother to dispute any of this. Yet to state that a detailed understanding of the unfolding of a topographical pattern in the embryo is a basis for comprehending the detailed pattern in the adult is to come close to the statement of a tautology. To insist that a study of embryology helps the student to understand the occasional congenital abnormality met with in clinical practice is also to state the obvious; and suggests the logical conclusion that proportionately as little time should be devoted to the subject as is taken up in clinical practice by malformations. To state that the subject has a cultural value is merely to underline what should be a quality of the entire curriculum of the medical student. One may well ask oneself whether the whole pattern of these considerations is important in the educational problem which the average medical student constitutes.

For in any event the student has to take embryology very much as a matter of faith. In Great Britain he practically never examines a section of a human or pig embryo, still less a set of serial sections—among other good reasons, for the very important one that adequate study of such material is a very time-consuming affair. Consequently the 'stills' and diagrams of his text-books represent the only direct experience the average student has of dynamic developmental processes. Such slender foundations scarcely sustain a scientific discipline. Even if they did, it is difficult to see what particular good it would be to the budding medical man. Books like Prof. Patten's are, in short, admirable guides for the student who has the opportunity and desire to study organogenesis in the laboratory itself. But they are much more than is wanted—to quote his own words—for the successful understanding of "the emergence of the various organ systems from undifferentiated primordial tissues to a point where he can recognize the beginnings of familiar adult structures"—which is about all one is likely to ask of the average medical student of to-day. What he wants is some short text that briefly explains what is known about the recognized principles of morphogenesis, and which is illustrated by really competent diagrams of the main stages in organogenesis. Since we are dealing with processes, and not fixed structures, it would be still better if one could call upon the talents of a first-class producer of 'animated films' to provide really good films of embryonic development. That would still be several steps from the original material of the subject; but it would be far closer than the student gets to-day.

For all this, there can be little doubt that Prof. Patten's main reading public will, in fact, be hurried medical students. One hopes, however, that it will receive more earnest employment as well. For topographical embryology does not need to be excused by over-emphasizing its utilitarian value in medical education. It stands in its own right, as an essential part of the story of development—and without which morphology would be only half a science. From this point of view we may count ourselves as lucky that there are always some departments of anatomy that provide the subject with a secure home. S. ZUCKERMAN

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[1] *Nature*, 156, 315 (1945).

HÆMOGLOBIN AND NITROGEN FIXATION IN THE ROOT NODULES OF LEGUMINOUS PLANTS

By PROF. D. KEILIN, F.R.S., and J. D. SMITH
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IT has been shown by Kubo[1] that the root nodules of leguminous plants contain a hæmoprotein compound resembling hæmoglobin and probably acting as a store as well as a carrier of oxygen. The hæmatin nature of this pigment was confirmed by Burris and Haas[2], who believed, however, that it was not a hæmoglobin-like compound which could undergo oxygenation, but rather an oxido-reduction catalyst in which the iron changes its valency. That this pigment is a true hæmoglobin was demonstrated by Keilin and Wang[3], who purified it and found that: (1) it forms a perfectly reversible compound with molecular oxygen; (2) it has a high affinity for oxygen, the p_{50} at 15° being less than 0·1 mm. mercury; and (3) the relative affinity of this pigment for oxygen and carbon monoxide in terms of the equilibrium constant $K = [\mathrm{HbCO}]\,[p\mathrm{O}_2]/[\mathrm{HbO}_2]\,[p\mathrm{CO}]$ is about 37 at 15° C. They also determined the spectrophotometric absorption curves of this hæmoglobin and of its compounds with oxygen and carbon monoxide.

The constant presence of this pigment in effective nodules of all leguminous plants, and the fact that nitrogen fixation in these nodules is inhibited by very low partial pressure of carbon monoxide, suggested that the hæmoglobin is in some way connected with the process of nitrogen fixation.

The presence of hæmoglobin in nodules was confirmed by Virtanen[4] and by Virtanen and Laine[5]. They, however, claimed that in addition to hæmoglobin the root nodules always contain methæmoglobin, the concentration of which increases when the plants are placed in the dark. They assumed that in nitrogen fixation the function of hæmoglobin is connected not so much with its property of oxygenation to oxyhæmoglobin as with its oxidation to methæmoglobin.

It must be remembered that whereas hæmoglobin (Hb) and oxyhæmoglobin (HbO_2) are compounds of divalent iron, methæmoglobin (Methb), which is a true oxidation product of hæmoglobin, contains trivalent iron.

In the present communication we propose to give a brief account of our study of the state of hæmoglobin within the nodules of plants kept under different conditions, and to examine the suggestions put forward by Virtanen and Laine[5] as to the mode of action of hæmoglobin in the nitrogen fixation by nodules.

State of Hæmoglobin in Nodules of Plants in the Light and in the Dark

The plant used in our investigations was the soya bean. The nodules were produced by three strains of *Rhizobium*: 505 and 507 supplied by Dr. H. G. Thornton of Rothamsted Experimental Station, and the strain 2196 obtained from the National Collection of Type Cultures. Two of these, 505 and 2196, were 'effective' strains, whereas the strain 507 was 'ineffective'. The experiments were carried out between June and September 1946 with plants grown either in nutrient solutions or in soil, and the seeds were germinated either in sterilized sand or in unsterilized soil. The state of the hæmoglobin was determined by direct spectroscopic examination of nodules immediately after their removal from the roots. For this purpose each nodule is washed, and cut with a razor blade into three slices. The central slice with parallel surfaces is placed on a slide in a drop of water and examined with the microspectroscope, using a strong source of light. Other nodules were examined crushed between two slides. Oxyhæmoglobin was recognized by the absorption bands at about 574 and 540 mμ, hæmoglobin by a single band at 557 mμ, whereas methæmoglobin, if present, should show a band at about 630 mμ. In certain cases sodium fluoride was added to the crushed or sliced nodule, which was then examined for the band of fluoride methæmoglobin lying at about 610 mμ.

Plants grown in nutrient solutions. On the opening of the second pair of leaves the seedlings, grown in sterilized sand, were transferred to 1·5 l. conical flasks containing a nutrient solution. The plants were inoculated by the addition to the nutrient solution of a suspension of a pure culture of *Rhizobium*. Three sets of plants nine weeks old bearing nodules produced by strains 505, 507 and 2196 of *Rhizobium* were each divided into two groups, one of which was left with the tops exposed to light, whereas the plants of the other groups were protected from light by wire cages covered with black cloth.

After eight days, several specimens of plants belonging to each of the six groups were removed and their nodules were examined spectroscopically. The main results of this examination can be summarized as follows: (1) nodules produced by the ineffective strain 507 were devoid of hæmoglobin both in specimens kept in the light and those in the dark; (2) nodules produced by effective strains (505 and 2196) contained only hæmoglobin and oxyhæmoglobin; no methæmoglobin was visible even in nodules of plants kept in the dark for about eight days; (3) on the addition of sodium fluoride to crushed nodules the band of fluoride-methæmoglobin, which slowly appeared, was very feeble and of the same intensity in nodules from plants kept in light and those in the dark.

Plants grown in soil. The seedlings were inoculated with a suspension of strain 505 of *Rhizobium*, and seventeen days later they were separated into two groups: the plants of one group were left in light, whereas those of the other group were transferred to closed containers in a darkened part of the greenhouse. Samples of both groups of plants were taken out and their nodules examined spectroscopically. After two and four days in the dark, only hæmoglobin and oxyhæmoglobin were present in the nodules, and no trace of methæmoglobin could be detected. After twelve days in the dark the leaves of the plants were yellow and falling. The contents of the nodules were brown and devoid both of hæmoglobin and methæmoglobin. The total hæmatin content of such nodules estimated as pyridine hæmochromogen was much lower than that of the nodules from normal plants.

This experiment was repeated using older plants which had begun seed production and were bearing larger nodules. Here again, in plants kept in the dark and examined daily, no methæmoglobin could be detected by direct spectroscopic examination of crushed or sliced nodules, and only after seven days in the dark was a small amount of fluoride-methæmoglobin formed on addition of sodium fluoride to crushed nodules.

Localization and Concentration of Hæmoglobin Within Nodules

We found it possible to demonstrate that within the nodule hæmoglobin is confined to the large cells containing *Rhizobium.* This was done either by direct microspectroscopic examination of thick slices of nodules, or by observing the distribution of the blue colour produced by the peroxidase action of hæmoglobin in microtome sections of nodules about 10 mμ in thickness treated with benzidine and hydrogen peroxide.

The concentration of hæmoglobin in the bacteria-containing cells of dwarf bean (*Phaseolus vulgaris*) nodules, estimated in crude extracts of nodules as pyridine hæmochromogen, was found to be about $1 \cdot 1 \times 10^{-4}$ gm. mol. hæmatin/l. The mean value obtained directly in slices of nodules and including hæmatin of cytochrome was $2 \cdot 3 \times 10^{-4}$ gm. mol. hæmatin/l. These estimations were carried out with the microspectroscope and the double-wedge trough, as previously described[6,7].

Hæmoglobin and Nitrogen Fixation in Nodules

Before the red pigment in nodules was recognized as hæmoglobin, Virtanen and his co-workers suggested that the first product of nitrogen fixation in nodules is hydroxylamine (NH_2OH), and that this combines with oxalacetic acid produced in the green portion of the plant to form the oxime, which on reduction gives rise to *l*-aspartic acid.

When the presence of hæmoglobin in nodules was definitely demonstrated[1,3], Virtanen and Laine[5] made an attempt to correlate its function with their hydroxylamine–aspartic acid mechanism of nitrogen fixation. For this purpose they found it necessary to postulate the valency changes of hæmoglobin iron and the reversibility of the reaction of decomposition of hydroxylamine by hæmoglobin.

According to Virtanen and Laine[5] the part played by hæmoglobin in nitrogen fixation can be represented schematically as follows:

$$\begin{array}{rcl} N_2 + \text{Methb (Fe}^{\text{III}}) & \rightleftharpoons & NH_2OH + \text{Hb (Fe}^{\text{II}}) \\ & & \big\downarrow + \text{oxalacetic acid} \\ l\text{-aspartic acid} & \xleftarrow{\text{reduction}} & \text{oxime} \end{array}$$

That the mechanism of nitrogen fixation involves a cyclic change of the valency of hæmoglobin iron is, according to them, supported by the following considerations: "The changes in the colour of nodules . . . depend on the intensity of light, and follow to a surprising extent the variations of oxalacetic content of the plant juice. On bright days the oxalacetic acid content of the plant juice is at its highest; during cloudy periods it falls sharply and after forty-eight hours in total darkness disappears completely." Accordingly, they claim to have found that "during cloudy days the brown colour deepens in the nodules as the balance is shifted to methæmoglobin".

The hydroxylamine–aspartic acid theory has already been carefully examined by Wilson[8] in his masterly review of the whole subject of nitrogen fixation in plants. We therefore propose to deal only with the views put forward by Virtanen and Laine[5] as to the mode of action of hæmoglobin in nitrogen fixation by root nodules. Even if their hydroxylamine–aspartic acid mechanism is accepted, several considerations, which we shall briefly examine, militate against their views of the part played by hæmoglobin in this mechanism.

(1) Our experiments failed to confirm their observations as to the presence of methæmoglobin in root nodules of plants even when the latter were kept in darkness for several days. On spectroscopic examination nodules show only the absorption bands of oxyhæmoglobin, which are gradually replaced by the single band of hæmoglobin. This deoxygenation, which is due to the normal respiratory activity of nodules including *Rhizobium*, is more rapid when nodules are examined compressed or crushed between two slides. The appearance of methæmoglobin in Virtanen and Laine's experiments was probably due to the fact that they worked with nodule extracts in which hæmoglobin undergoes oxidation by quinones formed during the extraction. In fact, the formation of methæmoglobin is more rapid in extracts from nodules of peas and beans, which are particularly rich in the polyphenol oxidase system, than in those of soya bean.

(2) The brown colour of nodules observed by Virtanen and Laine was not necessarily due to the formation of methæmoglobin, since the brown coloration of degenerating nodules, like that of other damaged plant tissues, may be due to the products of oxidation of phenolic substances by a polyphenol oxidase.

(3) Their statement that "methæmoglobin is reduced to hæmoglobin by the action of oxalacetic acid" is misleading, since oxalacetic acid reduces neither methæmoglobin nor any other hæmatin compound.

(4) The mechanism of decomposition of hydroxylamine by hæmoglobin is more complicated than was shown in the equation given by these workers and which was based on Letsche's observations[9]. In fact, the investigations by Lipschitz and Weber[10] and Roche[11] demonstrated that not only nitrogen, but also oxygen, ammonia and possibly nitrate are formed in the course of the catalytic oxidation of hydroxylamine by oxyhæmoglobin, the oxygen liberated from the latter being partly used in the oxidation reactions. Were Virtanen and Laine right in representing the formation of hydroxylamine as a part of a reversible equilibrium reaction of its decomposition by hæmoglobin, the production of hydroxylamine would require not only molecular nitrogen but also ammonia and possibly nitrate.

Conclusions

Our experiments clearly show that within the root nodules of leguminous plants hæmoglobin displays its usual property of oxygenation ($Hb + O_2 \rightleftharpoons HbO_2$). On direct spectroscopic examination, the nodules show only the mixture of hæmoglobin and oxyhæmoglobin. No methæmoglobin could be detected in nodules even if the plants were kept in the dark for several days. Neither experimental evidence nor general considerations support the view that the nitrogen fixation in root nodules involves a cyclical change of the valency of hæmoglobin iron. Moreover, it seems unlikely that oxido-reduction reactions in nodules are catalysed by a compound such as hæmoglobin, which has the remarkable property of oxygenation and is therefore an excellent oxygen carrier but a very inefficient catalyst. Although one cannot dismiss the possibility that under certain conditions hæmoglobin may act as an oxido-reduction catalyst, no evidence is so far available that this applies to hæmoglobin of root nodules.

On the other hand, the fact that this hæmoglobin is present in root nodules of every leguminous plant, that the pigment is formed only in nodules produced by an 'efficient' strain of *Rhizobium*, that the pigment is localized only within the large cells containing symbiotic organisms and that nitrogen fixation by nodules is strongly inhibited by small concentration of carbon monoxide, leave very little doubt that the activity of hæmoglobin is linked with the process of symbiotic nitrogen fixation. The presence of hæmoglobin in root nodules, therefore, will have to be taken into consideration in all further studies of nitrogen fixation by leguminous plants.

We are very grateful to Dr. H. G. Thornton for the strains 505 and 507 of *Rhizobium* used in this investigation.

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PROCESSES INVOLVING CHARGED MESONS

By Dr. C. M. G. LATTES, H. MUIRHEAD, Dr. G. P. S. OCCHIALINI and Dr. C. F. POWELL

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IN recent investigations with the photographic method[1,2], it has been shown that slow charged particles of small mass, present as a component of the cosmic radiation at high altitudes, can enter nuclei and produce disintegrations with the emission of heavy particles. It is convenient to apply the term 'meson' to any particle with a mass intermediate between that of a proton and an electron. In continuing our experiments we have found evidence of mesons which, at the end of their range, produce secondary mesons. We have also observed transmutations in which slow mesons are ejected from disintegrating nuclei. Several features of these processes remain to be elucidated, but we present the following account of the experiments because the results appear to bear closely on the important problem of developing a satisfactory meson theory of nuclear forces.

In identifying the tracks of mesons we employ the method of grain-counting. The method allows us, in principle[3], to determine the mass of a particle which comes to the end of its range in the emulsion, provided that we are correct in assuming that its charge is of magnitude $|e|$. We define the 'grain-density' in a track as the number of grains per unit length of the trajectory. Knowing the range-energy curve fc the emulsion[4], we can make observations on th tracks of fast protons to determine a calibratio curve showing the relation between the grain-densit in a track and the rate of loss of energy of the particl producing it. With this curve, the observed distri bution of grains along the track of a meson allows u to deduce the total loss of energy of the particle i the emulsion. The energy taken in conjunction wit the observed range of the particle then gives a measur of its mass.

We have found that the above method give satisfactory results when, in test experiments, it applied to the determination of the mass of proton by observations on plates developed immediatel after exposure. The errors in the observed value based on grain-counts along individual tracks, a only a little greater than those corresponding to th statistical fluctuations associated with the finit number of grains in a track. As we have previousl emphasized, however, serious errors arise whe the method is applied to the plates exposed for sever weeks to the cosmic rays[3]. These errors are du mainly to the fading of the latent image in the tim elapsing between the passage of the particle and th development of the plate.

We have attempted to allow for fading by detern ining a calibration curve for each individual plat by grain-counts on the tracks of a number of proton chosen at random from those originating in 'stars Such a calibration curve corresponds to an averag value of the fading of the tracks in the plate. Whil we thus obtain improved mean values for the mas of particles of the same type, as shown[3] by tes measurements on the tracks of protons other tha those used in making the calibration, the individu values are subject to wide variations. In no cas however, have mass determinations by grain-coun of particles, judged to be protons from the frequenc of the small-angle scattering, given values exceedi 2,400 m_e or less than 1,300 m_e.

In these circumstances it is not possible to pla serious reliance on the masses of individual meso determined by grain-counts; and we employ t method, in the present experiments, only to disti guish the track of a meson from that of a proton. I searching a plate, an experienced observer quick learns to recognize the track of a meson by inspectio provided that its range in the emulsion excee 100μ. Nevertheless, we regard it as established th a particular track was produced by a meson only both the grain-density and the frequency of t Coulomb scattering correspond to the values chara teristic of a particle of small mass. We have co sidered the possibility that as a result of a rare co bination of circumstances we might, in spite of t above precautions, wrongly attribute the track of proton to a meson of mass less than 400 m_e. It difficult to give a numerical estimate of the pro ability of making such an error, but we believe it be very small.

Secondary Mesons

We have now made an analysis of the tracks sixty-five mesons which come to the end of the range in the emulsion. Of these, forty show evidence for the production of a secondary partic The remaining twenty-five lead to the production secondary particles. Fifteen of them produce d integrations with the emission of two or more hea particles, and from each of the remaining ten

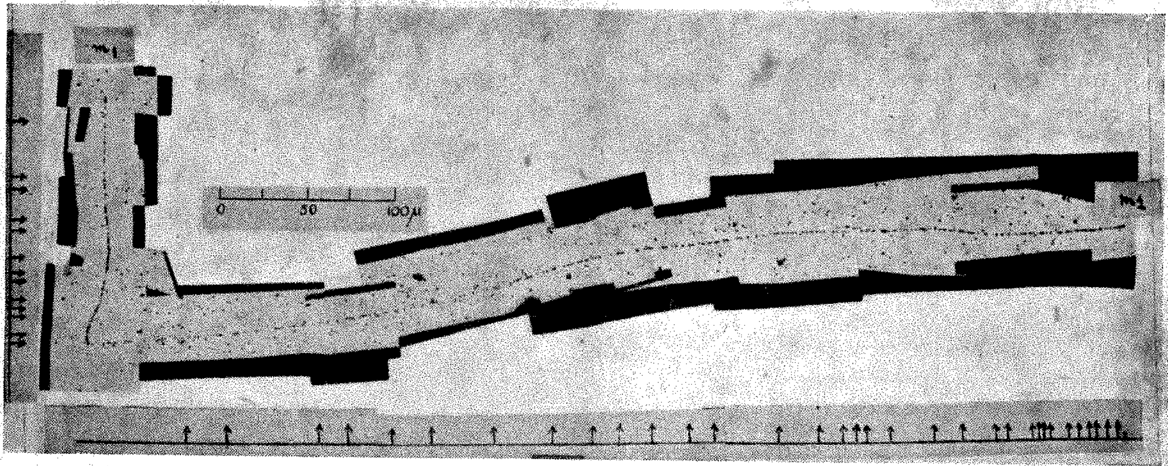

Fig. 1. OBSERVATION BY MRS. I. ROBERTS. PHOTOMICROGRAPH WITH COOKE × 45 'FLUORITE' OBJECTIVE. ILFORD 'NUCLEAR RESEARCH', BORON-LOADED $C2$ EMULSION. m_1 IS THE PRIMARY AND m_2 THE SECONDARY MESON. THE ARROWS, IN THIS AND THE FOLLOWING PHOTOGRAPHS, INDICATE POINTS WHERE CHANGES IN DIRECTION GREATER THAN 2° OCCUR, AS OBSERVED UNDER THE MICROSCOPE. ALL THE PHOTOGRAPHS ARE COMPLETELY UNRETOUCHED

observe a single secondary particle. Of these latter events, the secondary particle is in four cases a hydrogen or heavier nucleus; in four other cases the identification is uncertain, and in the last two cases it is a second meson.

Fig. 1 is a reproduction of a mosaic of photomicrographs which shows that a particle, m_1, has come to the end of its range in the emulsion. The frequent points of scattering and the rapid change of grain-density towards the end of the range show that the track was produced by a meson. It will be seen from the figure that the track of a second particle, m_2, starts from the point where the first one ends, and that the second track also has all the characteristics of that of a particle of small mass. A similar event is shown in Fig. 2. In each case the chance that the observation corresponds to a chance juxtaposition of two tracks from unrelated events is less than 1 in 10^9.

Grain-counts indicate that the masses of the primary particles in Figs. 1 and 2 are 350 ± 80 and $330 \pm 50\ m_e$, respectively; and of the secondary particle in Fig. 1, $330 \pm 50\ m_e$, the limits of error corresponding only to the standard deviations associated with the finite numbers of grains in the different tracks. All these values are deduced from calibration curves corresponding to an average value of the fading in the plate, and they will be too high if the track was produced late in the exposure, and too low if early. We may assume, however, that the two-component tracks in each event were produced in quick succession and were therefore subject to the same degree of fading. In these circumstances the measurements indicate that if there is a difference in mass between a primary and a secondary meson, it is unlikely that it is of magnitude greater than 100 m_e. The evidence provided by Fig. 2 is not so complete because the secondary particle passes out of the emulsion, but the variation in the grain density in the track indicates that it was then near the end of its range. We conclude that the secondary mesons were ejected with nearly equal energy.

We have attempted to interpret these two events in terms of an interaction of the primary meson with a nucleus in the emulsion which leads to the ejection of a second meson of the same mass as the first. Any reaction of the type represented by the equations

$$A_Z^N + \mu_{-1}^0 \rightarrow B_{Z-2}^N + \mu_{+1}^0 \text{ or } A_Z^N + \mu_{+1}^0 \rightarrow C_{Z+2}^N + \mu_{-1}^0, \quad (1)$$

in which A represents any stable nucleus known to be present in the emulsion, involves an absorption

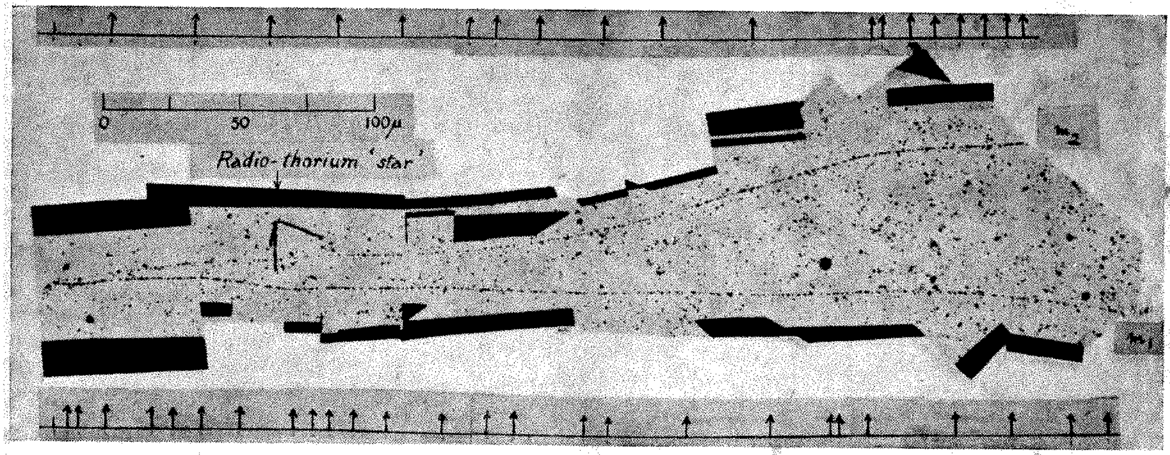

Fig. 2. OBSERVATION BY MISS M. KURZ. COOKE × 45 'FLUORITE' OBJECTIVE. ILFORD 'NUCLEAR RESEARCH' EMULSION, TYPE $C2$, BORON-LOADED. THE SECONDARY MESON, m_2, LEAVES THE EMULSION

of energy, in contradiction with the fact that the secondary meson is observed to have an energy of about 2 MeV.

A second process, represented by the equation

$$\mathrm{Ag}_{47} + \mu^{0}_{-1} \rightarrow X_{Z} + Y_{47-Z} + \mu^{0}_{+1}, \qquad (2)$$

in which X and Y represent two nuclei of approximately equal charge number, may be energetically possible, but the chance of it occurring in conditions where the total energy of the two recoiling nuclei is of the order of only a few million electron-volts is remote. It is therefore possible that our photographs indicate the existence of mesons of different mass[5,6,7]. The evidence provided by grain counts is not inconsistent with such an assumption. We have no direct evidence of the signs of the charges carried by the two mesons, except that the one secondary meson which comes to the end of its range in the emulsion does not lead to a disintegration with the emission of heavy particles. If, however, we assume that the transmutation corresponds to the interaction of the primary meson with a light nucleus, of a type represented by the equation

$$\mathrm{C}^{12}_{6} + \mu^{0}_{-1} \rightarrow \mathrm{Be}^{12}_{4} + \mu^{0}_{+1}, \qquad (3)$$

the difference in mass of the two mesons must be of the order of 60 m_e, according to estimates of the mass of the beryllium nucleus.

The only meson theory, to our knowledge, which assumes the existence of mesons of different mass is that of Schwinger[8]. It is visualized[9] that a negative vector meson should have a very short life and should lead to the production of a pseudo-scalar meson of the same charge but lower mass, together with a quantum of radiation. It will therefore be of great interest to determine whether the secondary meson, in transmutations of the type we have observed, is always emitted with the same energy. If this is so, we must assume that we are dealing with a more fundamental type of process than one involving particular nuclei such as is represented in equation (3). If, as an example of such a process, we assume that the momentum of the secondary meson appearing in our experiments is equal and opposite to that of an emitted photon, the total release of energy in the transmutation is of the order of 25 MeV.

In recent communications[10,11] very radical conclusions have been drawn from the results of observations on the delayed coincidences produced by positive and negative mesons in interactions with light and heavy nuclei[12,13]. It is assumed that a negative meson, at the end of its range, falls into a K orbit around a nucleus. In the case of a heavy nucleus, it is then captured, giving rise to a disintegration with the emission of heavy particles. With a light nucleus, on the other hand, it is regarded as suffering β-decay before being captured, so that like a positive meson, it can produce a delayed coincidence. The conclusion is drawn that the nuclear forces are smaller by several orders of magnitude than has been assumed hitherto. Since our observations indicate a new mode of decay of mesons, it is possible that they may contribute to the solution of these difficulties.

Emission of Mesons from Nuclei

Fig. 3 shows a mosaic of photomicrographs of a disintegration in which six tracks can be distinguished radiating from a common centre. The letters at the edge of the mosaic indicate whether a particular track passes out of the surface of the emulsion, *s* into the glass, *g*, or ends in the emulsion, *e*. The grain-density in tracks *a* and *c* indicate that the time between the occurrence of the disintegration and the development of the plate was sufficiently short to avoid serious fading of the latent image.

The track marked *f* suffers frequent changes in direction due to scattering, and there is a very rapid change in the grain-density in moving along the trajectory. These two features, taken together make it certain that the track was produced by light particle, and grain counts give an estimate fo the mass of 375 ± 70 m_e[14].

We have now observed a total of 1,600 disintegra tion 'stars', in each of which three or more charge particles are ejected from a nucleus. Of these, 17 correspond to the liberation of an amount of energ equal to, or greater than, that in the 'star' represente in Fig. 4, but only in two cases can we identify a

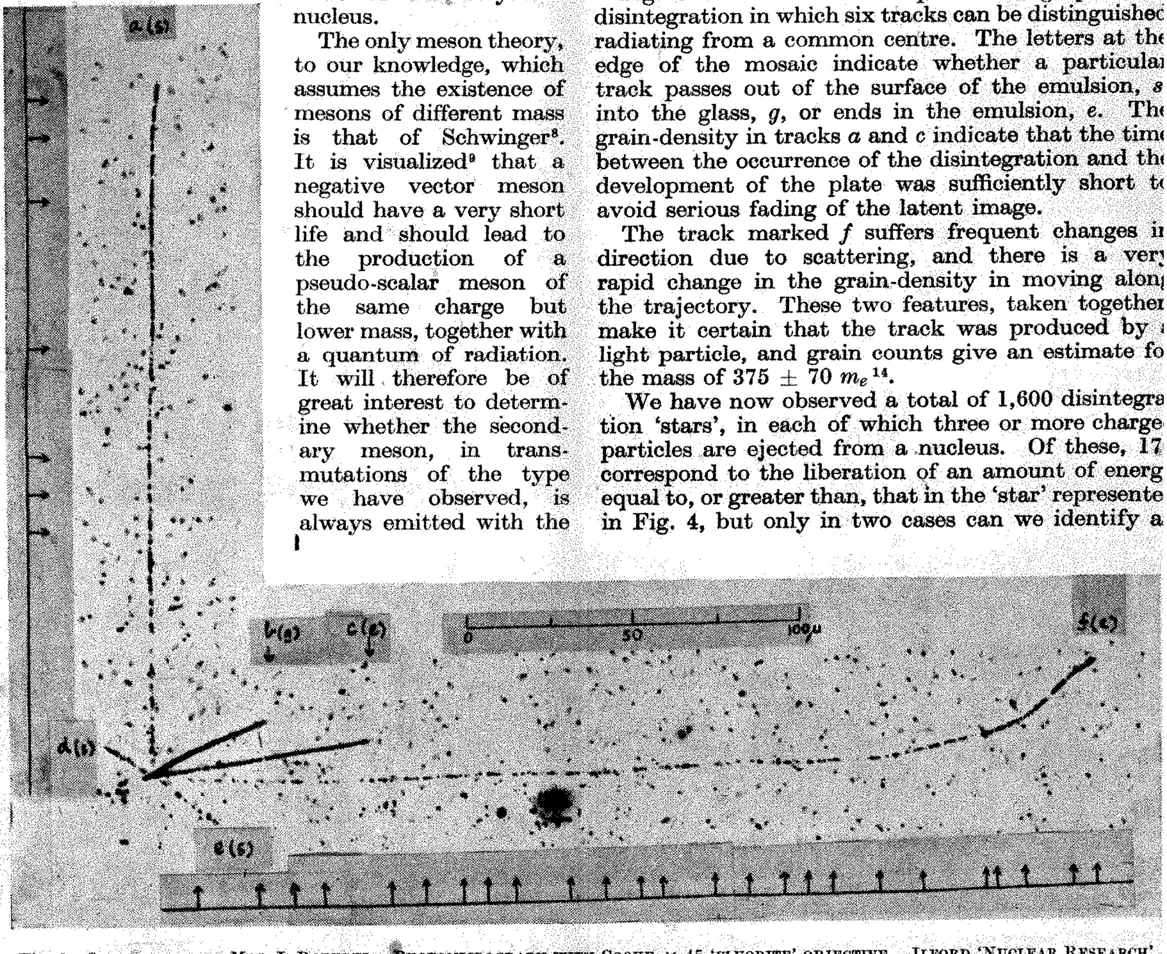

Fig. 3. OBSERVATION BY MRS. I. ROBERTS. PHOTOMICROGRAPH WITH COOKE × 45 'FLUORITE' OBJECTIVE. ILFORD 'NUCLEAR RESEARCH', BORON-LOADED C2 EMULSION. THE TRACK (*b*) DIPS STEEPLY AND ITS APPARENT GRAIN DENSITY IS GREATER THAN THE TRUE VALUE THROUGH FORESHORTENING. BOTH (*b*) AND (*c*) WERE PROBABLY PRODUCED BY α-PARTICLES

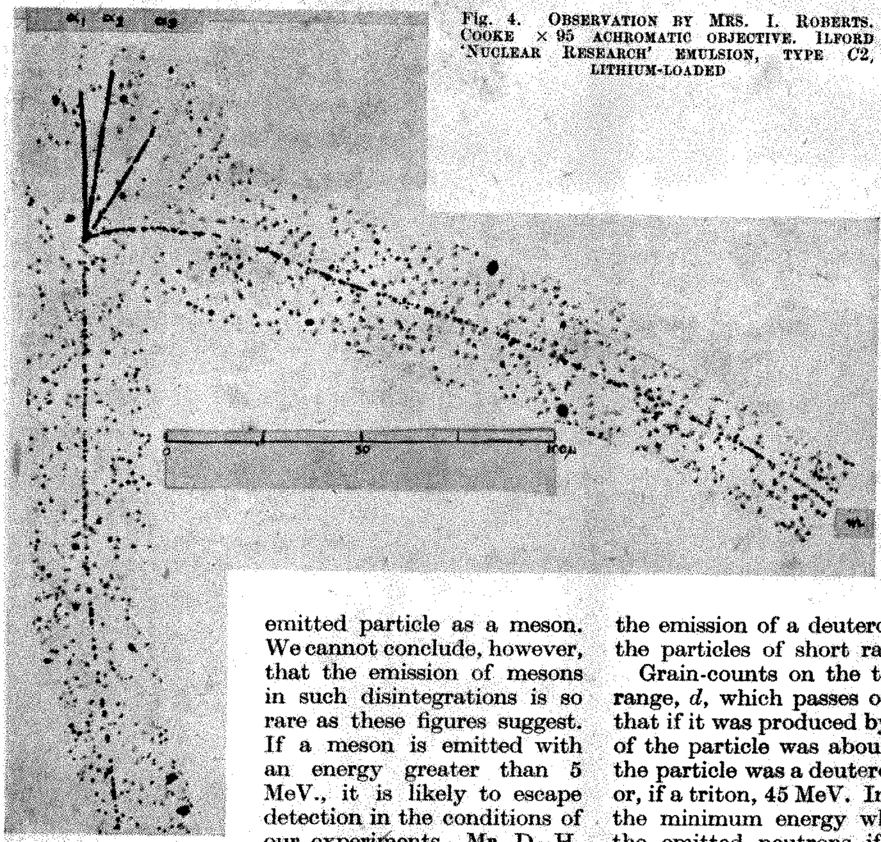

Fig. 4. OBSERVATION BY MRS. I. ROBERTS. COOKE × 95 ACHROMATIC OBJECTIVE. ILFORD 'NUCLEAR RESEARCH' EMULSION, TYPE $C2$, LITHIUM-LOADED

emitted particle as a meson. We cannot conclude, however, that the emission of mesons in such disintegrations is so rare as these figures suggest. If a meson is emitted with an energy greater than 5 MeV., it is likely to escape detection in the conditions of our experiments. Mr. D. H. Perkins, of the Imperial College of Science and Technology, has shown that, in the B_1 emulsion, the grain-density in the track of a meson becomes very small at energies greater than 2 MeV., and we must anticipate a similar result in the C_2 emulsion at higher energies. Our observations are therefore not inconsistent with the view that the ejection of mesons is a common feature of the disintegration of nuclei by primary particles of great energy, and that the present instance, in which the velocity of ejection has been exceptionally low so that an identification of the particle has been possible, is a rare example. It is possible that the example of meson production recently described[15] is due to a similar process, produced by a primary particle of higher energy, in which some of the heavier fragments emitted on the disintegration have escaped detection because of the depth inside the lead plate at which the event occurred.

The disintegration shown in Fig. 3 may be the representative of a type, common in the high atmosphere with particles of great energy. In the present instance the energy of the primary particle must have been of at least 200 MeV., and, if its mass was equal to or less than that of a proton, it would not have been recorded by the emulsion.

Disintegrations Produced by Mesons

The observation of the transmutations of nuclei by charged mesons has led to the suggestion of a method for determining the mass of these particles based on observations of the total energy released in the disintegration[1,2]. In attempting to apply the method, we meet the difficulty of identifying the particular type of nucleus undergoing disintegration and of taking account of any ejected neutrons which will not be recorded by the emulsion. A photograph of such a disintegration which, at first sight, appears to allow us to draw definite conclusions, is shown in Fig. 4. In the photograph, the tracks of four heavy particles can be distinguished, of which the short tracks α_1, α_2 and α_3 end in the emulsion; α_1 and α_2 were certainly produced by α-particles, and grain-counts show that α_3 is due to a proton. The observations are therefore consistent with the equation

$$N^{14}_{7} + \mu^{0}_{-1} \rightarrow 2He^{4}_{2} + H^{1}_{1} + H^{1}_{1} + 4n^{1}_{0}; \quad (4)$$

or, less probably, to a similar equation involving the emission of a deuteron or a triton in addition to the particles of short range.

Grain-counts on the track of the particle of long range, d, which passes out of the emulsion, indicate that if it was produced by a proton, the initial energy of the particle was about 15 MeV. Alternatively, if the particle was a deuteron, its energy was 30 MeV.; or, if a triton, 45 MeV. In any case, we can determine the minimum energy which must be attributed to the emitted neutrons if momentum is to be conserved in the disintegration. As a result, we find a minimum value for the mass of the primary meson of 240 m_e. The value determined by grain-counts is also 240 ± 50 m_e.

In view of the recent results of experiments on delayed coincidences, referred to previously[12,13], such results must, for the present, be accepted with great reserve. We must expect the liberation of an amount of energy of magnitude 100 MeV. in any nucleus to lead to the ejection of several particles, some of which may be neutrons. There is therefore no firm basis for assuming that the disintegration represented in Fig. 4 corresponds to the disintegration of a nucleus of nitrogen rather than one of silver or bromine. Indeed, the delayed coincidence experiments suggest that the second assumption is the more probable. When a sufficient number of observations with loaded plates has been accumulated, it may be possible to draw more definite conclusions from observed regularities in the modes of disintegration of particular types of nuclei.

A detailed account of the experiments will be published elsewhere.

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UNIVERSITIES AND THE COMMUNITY

THAT public discussion on such a subject as "The Place of Universities in the Community" would range over a wide field was to be expected, and the one-day conference on that subject arranged by the British Association on May 10 at the University of Manchester proved no exception. The immediate purpose of the conference, to discuss important problems arising out of the projected expansion of the universities of Great Britain, tended at times to be overlooked by those who took part in the discussions at both sessions, and while the conference made some contribution to the education of public opinion as to what is involved in the expansion of the universities, particularly on the scientific side, little was added to what has already emerged in the debate between men of science and others on these questions, both before and after the appearance of the Barlow Report.

The first of the two sessions was devoted specifically to the consideration of the implications of the Barlow Report. Lord Simon of Wythenshawe, who presided over this session, did his best to keep the discussion on realistic lines but contented himself in his opening remarks with presenting the administrative background to the Barlow Report, pointing out that it was only one of a number of such official reports dealing with the question of capacity of the universities to provide the trained men and women which the community requires. He referred specifically to the earlier Goodenough, Teviot, McNair and Clapham Reports, and to the more recent Scarborough Report; but in view of what was said later by Prof. M. Polanyi, he might well also have cited the earlier Barlow Report on scientific staff. Lord Simon then quoted from the "Note on University Policy and Finance in the Decennium 1947–56" (which was discussed in *Nature* of April 12, p. 483), and emphasized the acceptance by the universities of the view that the Government has the right and the duty to satisfy itself that every field of study which in the national interest ought to be cultivated in Great Britain is in fact being adequately cultivated in the universities, and that the universities are using their resources with full regard both to efficiency and to economy. If the universities are collectively to devise and execute policies calculated to serve the national interest, the University Grants Committee would require strengthening, and Lord Simon referred to the recent appointment of a whole-time deputy chairman and to the Chancellor of the Exchequer's indication of the ultimate expansion of the grant to the universities to be administered by the Committee to at least £16–£20 millions as against £2–£4 millions before the War.

These figures were probably less effective in indicating what is immediately involved than Lord Simon's incidental remark that doubling the output of scientific workers within five years is a rate of expansion much greater than has ever been contemplated in the United States. The administrative and financial aspects were, however, scarcely again considered in the discussion. Prof. P. M. S. Blackett, who followed, thought that sufficient talent is available to provide the increased number of scientific workers required, and referred in particular to the reserve demand for such trained individuals represented by the teaching profession and by private industry, which probably needs more men of science than it recognizes. He urged that the Barlow Report should be followed by a further statistical inquiry into both the sources from which students enter the universities and the future of the graduates when they leave them.

One at least of these lines of thought was pursued by Dr. Eric James, high master of the Manchester Grammar School, who urged that the great weakness of the Barlow Report is that no evidence was taken from the schools as to their capacity to provide the requisite number of potential science graduates. He thought that the report made insufficient allowance for the number of trained science teachers required in the schools, on the quality of whose work in the schools, he maintained, the work of the universities rests. He urged that it should be a priority of the first order to discover where in the educational ladder the wastage of intelligence and talent occurs; emphasizing that we should remember that the educational system is a whole and not consider the universities apart from the schools, he pointed out that so far we have failed to formulate in any specific terms our ideas as to a general education for scientific workers.

This plea was later taken up by Sir John Lennard-Jones. He urged that, as providing a link between the nation's intelligence and public affairs, the university has a duty to the State and should make a point of being fully and accurately informed as to the nation's need for trained workers, and moved a resolution which was seconded by Prof. J. D. Bernal and adopted at the end of the session. The resolution recommended to the Council of the British Association that the University Grants Committee be invited, in collaboration with the universities, (1) to make extensive factual surveys of the openings for graduates in the national life; (2) to maintain records of the careers of university graduates and the measure of their success in their professions; and (3) to publish periodic reports of the results of such surveys for the guidance of universities and schools. Whatever reservation individuals may have felt about the wisdom of asking the University Grants Committee to undertake this task—and misgivings were expressed in private if not publicly—the importance of university co-operation in appointments work was fully recognized, although no one pointed out that the Hankey Committee has already recommended that this work should be undertaken by the Higher Appointments Department of the Ministry of Labour.

Other points raised in the morning discussion were the age at which choice of a scientific career is usually determined, the detrimental effect of existing overcrowding and of the shortage of teaching staff. The importance of careful selection of students in university expansion and of encouraging adaptability and discouraging the intensive specialization which hinder mobility were noted. Mr. Ritchie Calder, commenting on the danger of middle-class unemployment, urged that greater emphasis should be placed on the regional character of the university; a position in which only 10 per cent of science graduates from Scottish universities find employment in Scotland is most unsatisfactory.

Opening the second session of the conference, which was to consider more specifically research and organisation, Sir Henry Dale, who presided, suggested that with the universities dependent on the Government for more than seventy-five per cent of their income, the influence of Government departments might become a serious factor in the expenditure of funds on research. Sir Henry Dale voiced once more the fears that he has often expressed that the war-time practice of the universities of carrying out research on subjects laid down by outside authorities might be perpetuated. He emphasized the vital importance of the universities maintaining, in Britain and elsewhere, their full independence, and reiterated that the proper function of the universities is to promote free research with no immediate objectives but to widen the boundaries of knowledge, in contradistinction to prescribed research undertaken for the particular end of solving an immediate practical problem.

No evidence was given during the meeting that either industry or the Government is offering research endowments to the universities to which restrictive or secrecy conditions are attached, and it is noteworthy that all recent reports on research and the universities which have recognized the increasing dependence of the universities on Government financial support have been confident of the ability of the universities to maintain their independence. Nevertheless, the afternoon session adopted the resolution moved by Sir Henry Dale recommending the Council of the British Association to make representations to the competent authorities of all universities in the British Empire, urging that under the normal conditions of peace no contract for research should be accepted by the scientific departments of any of these universities if its terms included any restriction on freedom of publication.

In their plea for a follow-up of the Barlow Report by an investigation of the educational ladder at the school stage, Prof. Blackett and Dr. James introduced the first new distinctive note; Prof. M. Polanyi struck the second. In a paper on the organisation of universities, without pursuing the secrecy theme, Prof. Polanyi spoke strongly for the universities as the natural nurseries and homes of fundamental research. He recognizes the twin relations of teaching and research, and he pleaded that the advancement of learning depends on the universities being maintained as the well-springs of discovery. As Sir Henry Dale had said, it is the function of the university to hold aloft the search for truth in all its aspects; but when Prof. Polanyi added that it is waste of time to endow academic research workers unless the recipients are left free to use the funds at their own discretion, he gave expression to a principle which might well be re-considered by those industrial firms who have, as he indicated, tended to enter the academic field. Doubtless the distinction may not always be easy to maintain, but Prof. Polanyi equally insisted that the university itself should be careful not to be tempted into the investigation of practical problems which lie outside its own experience.

This most significant passage in Prof. Polanyi's paper was rather overlooked in the discussion, which seized, first on his reference to the importance of refusing to fill vacancies in senior appointments with men or women below a certain level of distinction, and of not regarding too closely the special field of inquiry, even if this involves some over-crowded departments and others with chairs vacant indefinitely; and secondly, on his defence of some disparity between academic salaries and those of other professional positions in industry or elsewhere. Prof. Polanyi also maintained that unless society appreciates science for its own sake, it will not continue for long to cultivate genuine scientific research, and accordingly in the long run the universities depend for their existence on the recognition of cultural obligations by the nation. He also insisted that since it is impossible to recognize and subsidize all the growing points of science, the universities, which uphold the broad principle that their task is to supply individual creative minds with the opportunities to do the work of their own choice, cannot agree with the Vice-Chancellor's Committee that it is their function to plan to meet the whole range of national need for higher teaching and research.

Prof. Bernal did not altogether follow Prof. Polanyi in this view. His discussion of research was obviously coloured by his recent experience of war-time conditions, and he distinguished research as of two types: subjective research, which he agreed should be left to the universities, and the objective and prescribed research, distinguished by Sir Henry Dale. While subjective research is the proper function of the universities, Prof. Bernal insisted that the greater need is for a new type of research worker and director able to integrate this with other activities. He urged that social and economic problems can likewise be tackled on scientific lines; here he was obviously less concerned with the creative aspect and the freedom of choice stressed by Prof. Polanyi than with the question of organisation and the fact that the individual scientific worker might exercise his choice without adequate knowledge. He supported both the regional work of the university—regional contacts, he believes, will help to suggest continually fruitful problems for investigation by the universities, which should make it their business to discover the needs and problems of the region—and the cultural value of scientific research. We need a unitary culture which to-day must contain a scientific method, just as the experimental method would play a part in uniting knowledge. If an adequate social philosophy is not yet fully formed, we have at least learned that the whole approach to social problems as well as to physical problems should be scientific.

In a somewhat rambling discussion, little was said which had not already been ventilated in previous reports on the universities and research. Some points in that from the Association of Scientific Workers in particular were mentioned. The claims of social science as presented in the Clapham Report, and also of adult education, on the support of the universities were also emphasized. Dr. C. H. Desch referred to the changing outlook in the steel industry and to the demand for scientific workers for research and management positions in contrast to a demand merely for testing work, and to the way in which patents policy offsets the obsolete tendency to secrecy in industrial research. Commenting on the need for providing for the new growing points in science, Prof. Polanyi's suggestion that chairs should be left vacant found some support, Dr. Gordon observing that the universities should make it clear to the Government beforehand that they do not propose to retain inferior men in professorial chairs even if appointed on trial. His comment about differentiation in salary scales, however, was challenged; Prof. Polanyi had not denied that university salaries are in need of revision upwards; the scientific worker in a university should be remunerated on a scale which permits him to maintain a family.

OBITUARIES

Prof. V. M. Goldschmidt, For.Mem.R.S.

Victor Moritz Goldschmidt, the eminent geochemist, formerly professor of mineralogy and geology in the University of Oslo, died on March 20.

He was born in Zurich in 1888, the son of H. J. Goldschmidt, who became professor of chemistry at Oslo in 1900. He entered the University of Oslo in 1905, taking as his main subjects chemistry, mineralogy and geology, and there came under the inspiring influence of Prof. W. C. Brögger, whom he was eventually to succeed. He was appointed professor and director of the Oslo Mineralogical Institute in 1914 at the early age of twenty-six. A highly successful teacher, he founded a large research school both at Oslo and at Göttingen, where he moved in succession to Mügge in 1928. Many of his former pupils now hold professorships or high posts in industry, in Europe or America.

Goldschmidt resigned the Göttingen chair in 1935 as a protest against the Hitler regime, and returned to Norway. In 1942 he was sent to a concentration camp by the Germans and sentenced to deportation to Poland, but escaped to Sweden and offered his services to the Allies. He came to Britain in the spring of 1943 and worked under the auspices of the Agricultural Research Council; the first year he spent at the Macaulay Institute for Soil Research, Aberdeen, and later went to Rothamsted Experimental Station, where he remained until his return to Oslo in 1946. For some of the particulars of this notice I am indebted to Dr. W. G. Ogg of Rothamsted and to Dr. R. C. Evans at Cambridge.

Goldschmidt's researches divide themselves broadly into an early group of studies (1911–20) devoted chiefly to petrology and geology; the main group of fundamental geochemical investigations which followed from 1920; and the pioneer crystallochemical studies (1925–27) which developed naturally from them and in turn served to interpret his later work.

His researches in the field of rock metamorphism have been of the first importance. The study he made of the metamorphic aureoles around the igneous massifs of the Oslo district marked a major advance in the correlation of the chemical and mineralogical composition of thermally reconstituted rocks, and contained the first successful essay towards a systematic classification of rock mineral assemblages in the light of the phase rule. Equally important were his investigations on the zonal metamorphism of the crystalline schists of the Palæozoic mountain region of southern Norway, forming as they did a genetic study of rocks re-crystallized under shearing stress and high temperature developed during regional folding and igneous injection.

Goldschmidt's researches in geochemistry were initiated during the First World War when the deficiency of raw materials led him to extended investigations on the mineral resources of Norway. The organisation of this research was entrusted to him by the Norwegian Government in 1917, and he became chairman of the Commission for Raw Materials and director of the Raw Materials Laboratory.

After the War, with a keen research team, he applied himself with great energy to the study of the basic problem of geochemistry—the discovery of the general laws and principles governing the distribution of the chemical elements in Nature. To this end both old and new methods of chemical and physical analysis were brought to bear on the investigation of rocks and minerals. X-ray analysis and quantitative spectrographic methods provided new lines of attack, and he developed later, particularly at Göttingen, an improved technique of carbon arc spectrography.

These studies led directly to his work in crystal chemistry, the most important of his results in this field appearing in the brilliant group of memoirs published in 1925–27: "Geochemische Verteilungsgesetze der Elemente" (iv–viii). His researches on the crystal structure of ionic compounds may indeed be regarded as laying the foundation of the science of crystal chemistry. By the systematic investigation of a wide range of compounds, he was able to formulate the picture of an ionic structure as being determined primarily by the geometrical packing of ions of characteristic sizes, and to tabulate for the first time values of ionic radii for the majority of the elements. These data in their turn provided a basis for the understanding of the problems of morphotropy, and led to an explanation of the morphological relationships which exist within groups of closely related compounds and to a correlation between physical properties and crystal structure.

The principles which Goldschmidt thus established were afterwards codified more formally but without essential modification by Pauling, and have been tacitly invoked in all later work on the X-ray study of ionic structures.

The elaborate series of geochemical investigations Goldschmidt began at Oslo and continued at Göttingen have revolutionized our knowledge of the distribution of the minor constituents of the earth's crust. He demonstrated the partition of a large number of the rarer elements among the successive products of the geological cycle—from the primitive magma to the sediments and the sea—and showed that ionic size and charge are important factors controlling their ultimate sorting and concentration.

Goldschmidt's industrial work was also of great importance. He was a pioneer in the development of forsterite as a commercial refractory, now in wide use; he worked out a process for making alumina from labradorite felspar, and took part in the development of titanium pigments. His interest in agriculture arose during the First World War when Norway was faced with a shortage of potash fertilizers. He suggested the possibility of using biotite as a source of potash, and though the idea was not altogether new, the resulting experiments he developed are probably the most complete set carried out to test the possibilities.

At Göttingen in connexion with his studies of trace elements, he and his colleagues examined samples of soil and tree leaves and showed the marked relative accumulation of certain trace elements in forest litter. What was probably his last publication was an article introducing a trace element symposium in *Soil Science*.

During his stay at the Macaulay Institute and at Rothamsted, Goldschmidt was generous with his advice and took a great interest in the work of trace-element distribution.

He had for some years been engaged on a comprehensive treatise on geochemistry. It is known that the greater part of this was written before he left England, and it is confidently expected that he was able to complete it for eventual publication.

C. E. Tilley

I wish to add to Prof. Tilley's account a few recollections of my personal relations with V. M. Goldschmidt. When he first came to Göttingen there was a latent tension between us, a mutual doubt regarding our work on ionic crystals: he considered my calculations of lattice energies cumbersome and scarcely worth while, and I had no confidence in his primitive way of adding ionic radii. But we soon discovered that these two methods were complementary, one providing exact values in a few simple cases, the other covering the whole field of crystal chemistry. After clearing the air, we became great friends. He was a remarkable man in many respects. His memory was stupendous. Once I sent an assistant to him to ask about literature on a great number of data. Instead of giving the titles of papers, he just dictated the numerical tables from memory, and a later check proved them essentially correct. He knew by heart not only the properties of atoms and ions, like radii, polarizabilities, etc., but also their occurrence in minerals and the distribution of these minerals in the earth's crust. If he did not know a fact, he had simple ways of deriving it from his radii.

Goldschmidt had a very original mind and a great sense of humour which sometimes found expression in a somewhat caustic manner. One had to take the trouble to look below the surface to discover a gentle and most generous nature which was easily wounded, and had no other defence than to hit out. To those who came to understand this, he was a devoted and most loyal friend, and they now mourn for one who has enriched their lives. M. Born

Prof. Ludwig Jost, For.Mem.R.S.

By the death on February 22 of Prof. Ludwig Jost, Germany has lost one of its most respected botanists and science one of the leading plant physiologists. Born in 1865 at Karlsruhe, he was educated at the local *Gymnasium*. In the autumn of 1883 he commenced his studies at the University of Heidelberg, attending particularly the lectures of Bütchli and Pfitzer. Afterwards he moved to Strassburg to study under de Bary. In 1887 he took his doctor's degree there, presenting a thesis on the breathing roots of palms. In the same year he was appointed assistant to Prof. Goebel in Marburg, and later returned to Strassburg, where he acted as assistant first to de Bary and after the death of the latter to Count Solms Laubach. In 1894 he was appointed assistant professor, and in 1907 to a full professorship in the University of Strassburg. In 1919, when the French re-entered that town, he had to leave, but was lucky enough to get an appointment to the vacant professorship at Heidelberg, which he held until his retirement in 1934. He was then elected emeritus professor and continued his scientific work privately in the Kaiser Wilhelm Institute at Heidelberg, where he died, having been failing in health for some years. He was always strongly averse to the Nazi regime, and his sufferings were accentuated by the poor nutrition since the end of the War.

His varied training as a student had given him a wide outlook in botany, and his own researches touched the fields of morphology as well as those of physiology. The first edition of his lectures on plant physiology appeared in 1904 and was sufficiently appreciated to be followed by three further editions.

He won for himself a considerable reputation both at home and abroad and was elected a foreign member both of the Royal Society and the Linnean Society. His personal kindliness and his unassuming manner endeared him to all with whom he came in contact. F. E. Weiss

We regret to announce the following deaths:

Sir Thomas Holland, K.C.S.I., K.C.I.E., F.R.S., principal and vice-chancellor of the University of Edinburgh during 1929–44, on May 15, aged seventy-eight.

Sir Frederick Gowland Hopkins, O.M., F.R.S., president during 1930–35 of the Royal Society, on May 16, aged eighty-five.

NEWS and VIEWS

Prof. E. Cartan, For.Mem.R.S.

Prof. Elie Cartan, who has just been elected a foreign member of the Royal Society, has been in the forefront of French mathematics since 1894, when his doctorate thesis on the structure of continuous groups was first published. In response to continued demand, it was reprinted forty years later. This subject has been Cartan's chief interest throughout his subsequent career as a mathematician. By 1900 Cartan had made fundamental contributions in another field, the problem of Pfaff. Two long memoirs on the subject appeared about this time in the *Annales de l'Ecole Normale*. It was in the first of these (in 1899) that he developed systematically the theory of 'exterior differential forms' which obey the laws of exterior multiplication of Grassmann. Throughout most of his subsequent work Cartan has found the method of 'exterior derivation' an extremely powerful one.

Cartan's chief contributions to the theory of relativity appeared between the years 1922 and 1925 when a systematic study of the gravitational equations of Einstein in the *Journal de Mathématique* was followed by a series of papers on relativity theory and affinely related spaces in the *Annales de l'Ecole Normale*. These last may be said to mark the beginnings of his major contributions to differential geometry, where he has found the method of the moving trihedron (*repère mobile*) of dominant significance. The essential unity of Cartan's ideas in different branches of mathematics is well illustrated by a tract which he published in the "Actualités" series in 1935, in which he shows that the theory of the moving trihedron has an intimate connexion with the equations of structure of a continuous group, and that the equations of structure of a group G contain in themselves all the differential geometry of the space having G as fundamental group.

Organic Chemistry at Edinburgh: Prof. E. L. Hirst, F.R.S.

Prof. E. L. Hirst, at present Sir Samuel Hall professor and director of the Chemical Laboratories in the University of Manchester, has been appointed to the newly instituted Forbes chair of organic chemistry in the University of Edinburgh. Prof.

Hirst, who was born in 1898, was educated at the Northgate School, Ipswich, and Madras College, St. Andrews. After graduating M.A. in Latin, Greek and logic at the University of St. Andrews, Hirst proceeded there to the degrees of B.Sc. and Ph.D. in chemistry under Prof. (later Sir) J. C. Irvine. While at St. Andrews he made notable contributions to the chemistry of cellulose and the structure of simple sugars. He was an assistant in chemistry at St. Andrews during the brief professoriate of (Sir) Robert Robinson, and moved with him to Manchester. In 1924 Hirst was appointed lecturer in Armstrong College, University of Durham, where Prof. (now Sir) Norman Haworth, with whom he had worked in St. Andrews, had established a school of carbohydrate chemistry. Haworth was appointed to Birmingham in 1925, and in the following year Hirst followed him; Hirst was appointed reader in the chemistry of natural products in 1935. This period marked a tremendous advance in carbohydrate chemistry, when the ring forms of sugar and glycosides were given precise definition, the constitution of all the important disaccharides was established, and great advances in the chemistry of starch, glycogen and cellulose were made. Hirst's most spectacular work at this time was the determination of the constitution of ascorbic acid (vitamin C) and its synthesis (in association with Haworth), representing the first laboratory synthesis of a vitamin.

In 1936, Prof. Hirst was elected Alfred Capper Pass professor of chemistry in the University of Bristol; here he continued and extended his studies on carbohydrates to such highly complex bodies as pectins, plant gums and mucilages, and threw further light on the constitution of starch. This work was interrupted during the recent War, when all academic research at Bristol was discontinued. Hirst was appointed head of the Bristol Outstation Armament Research Department. He served on the Scientific Advisory Committee of Research and Development of the Ministry of Supply, and was chairman of the Explosives Committee (Chemistry) and of various panels during the period of hostilities. Since Prof. Hirst's appointment to the Manchester chair in 1944, his work has been mainly concerned with the development of new methods for end-group determinations for use in dealing with the problems of the structure of complex polysaccharides. Hirst served as an independent member of the Working Party for the Cotton Industry, and was chairman of its research sub-committee.

Dr. K. Mellanby, O.B.E.

DR. K. MELLANBY, who has been announced as principal designate of the new University College which it is proposed to establish in Nigeria, has had a varied career. Trained at Cambridge as a zoologist, he devoted himself in the years before the War to the study of insect physiology. First, at the London School of Hygiene and Tropical Medicine and in Uganda he did illuminating work on the water relations of insects. As Sorby Research Fellow of the Royal Society he transferred to Sheffield and studied particularly the adaptation of insects to cold, both in the laboratory and in the field—in arctic Finland. At the outbreak of the War, Dr. Mellanby's organising ability became apparent. A survey of the incidence of head-lice among children in fever hospitals throughout the country gave the first accurate picture of the distribution of pediculosis in Britain. Dr. Mellanby then turned to the scabies problem. Enlisting the co-operation of a team of 'conscientious objectors' to serve as experimental subjects, he was able to carry out a fine scientific and practical study of scabies which placed our knowledge of the incidence and spread of the itch mite and the efficacy of the various treatments on a really sound basis. The well-known film of this work was a valuable piece of propaganda.

After a period as scientific liaison officer in North Africa, Dr. Mellanby joined the team organised by the Medical Research Council to investigate the spread of scrub typhus. His particular province was the ecology of the mites which carry the disease; but he again put great energy into the propaganda side of the work, including the preparation of an instructional film. Extensive travel in America, Australia and the Pacific area provided more valuable experience. In 1945 he was appointed reader in entomology at the London School of Hygiene and Tropical Medicine. Dr. Mellanby's wide knowledge of the world, his organising ability and a gift for getting on well with all sorts of people promise success to this new venture.

Government Estimates for Scientific and Industrial Research

THE Civil Estimates for the year ending March 31, 1948, now published (Class VI) show a gross estimate of £3,449,375 for the Department of Scientific and Industrial Research, against which appropriations in aid amount to £331,086, the net increase on 1946–47 being £727,355. Grants for investigation and research are estimated at £1,182,000, an increase of £254,400 on 1946–47, of which £842,000 is represented by annual grants to research associations and bodies engaged in industrial research, and £240,000 by grants to students and other persons or bodies engaged in scientific research. Headquarters expenditure is estimated at £175,780 as against £129,604 in 1946–47, and the estimate for the National Physical Laboratory shows an increase from £423,180 to £489,459, with an increase in staff from 611 to 731. The estimate for the Chemical Research Laboratory is increased from £42,158 in 1946–47 to £57,753, with an increase in staff from 58 to 102. Expenditure on the Building Research Station is estimated at £192,390 as against £151,380, with an increase in staff from 255 to 374; on food investigation at £88,803 as against £78,365, with an increase from 111 to 136 in staff; on the Forest Products Research Laboratory at £69,929 as against £61,913, with an increase in staff from 77 to 112; on fuel research at £164,676, as against £137,340, with an increase in staff from 174 to 232; on the Pest Infestation Laboratory at £22,444 as against £19,386, with an increase in staff from 43 to 52; on the Road Research Laboratory at £152,929 as against £97,850, with an increase in staff from 147 to 233; and on the Water Pollution Research Laboratory at £29,754 as against £22,058, with an increase in staff from 51 to 74. The total staff is estimated at 2,129 as against 1,538 in 1946–47. For the Geological Survey and Museum of Practical Geology, expenditure is estimated at £187,704 as against £106,941.

This net total of £3,118,289 represents only a part of the Treasury contribution to research for the current year. In addition to the vote of £12,000,000 to the universities, part of which at least will be expenditure on research, the Civil Estimates include appropriations of £698,000 for the Medical Research Council, £400,000 for the Agricultural Research

Council, £1,977,450 for agricultural education and research under the Ministry of Agriculture and Fisheries, and £412,652 for agricultural research and experiments under the Department of Agriculture for Scotland; £144,450 for fisheries research, £374,000 for forestry research and education, £78,623 for fisheries research and development in Scotland, £500,000 for Colonial research, and £50,000 for the social survey. Miscellaneous grants in aid of scientific investigation include £53,000 to the Royal Society. The grand total is approximately £19,500,000. Although the Dominions Office vote includes a grant of £33,825 in aid of Imperial Economic and Research Services, and the Ministry of Food vote £4,500,000 for the production of ground-nuts in East and Central Africa, of which some small fraction is for research, it is unlikely that the total expenditure from the Exchequer in aid of civil research much exceeds £10,000,000 for the current year as against the £60,000,000 to be expended by the Ministry of Supply and the Admiralty, apart from the work which may be carried out by the Department of Scientific and Industrial Research for the Services.

Atomic Power in Sweden

THE Swedish Atomic Committee, which consists of ten leading men of science and technicians, has submitted a proposal to the Swedish Government, recommending the formation as soon as possible of a joint-stock company, AB Atomenergi, with a capital of about £241,000, of which about two thirds would be contributed by the State and the remainder by Swedish industry. The first task of the company would be to design and build an experimental plant for the liberation of atomic energy, and later on a plant for the production of atomic power on an industrial scale would be erected. The Committee also suggests that, in addition to 2,000,000 kronor already proposed in the current State budget, another 2,000,000 kronor should be appropriated for research work to be performed under the supervision of a new body, the Atomic Research Council. It is reported that the company will use uranium from shale deposits in the central Swedish provinces of Närke and Västergötland.

Suggested British Herpetological Society

AT an informal meeting held at the British Museum (Natural History) on April 10 the formation of a British Herpetological Society was considered. The Society would be formed with the view of increasing our present knowledge and promoting interest in various aspects of herpetology which, it is felt, have been somewhat neglected. Its main objects would be: (1) to encourage the study of the ecology, life-histories, habits and distribution of the Amphibia and reptiles, and of the British species in particular; (2) to publish annually a report on the work of the Society, and to review briefly advances in knowledge, particularly in the field of ecology; (3) to hold meetings, when possible, for the reading of papers and the discussion of problems relating to herpetology; (4) to record and compile information on the various aspects of the subject covered by the Society. Although such a Society would, of necessity, be concerned mainly with the study of British species, foreign membership would be most welcome. It is suggested that the annual subscription to the Society, including a free copy of the report, should be ten shillings. Those interested in the formation of such a Society should communicate with Capt. J. D. Romer, 96 Mortlake Road, Kew, Surrey. If the response is sufficiently large, further steps will be taken to inaugurate the Society, and individuals will be informed accordingly.

Association of Social Anthropologists

AN Association of Social Anthropologists was founded on July 23, 1946, in response to the general opinion among social anthropologists in Great Britain that the subject has reached a stage of development warranting the establishment of a professional organisation. Its objects are to promote the study and teaching of social anthropology as a specialized branch of anthropology; to represent the interests and maintain the professional standards of the subject; to arrange periodic conferences of the members of the Association; and to secure publication of researches under its auspices. It is intended to publish a journal, *Annals of Social Anthropology*, as soon as arrangements can be made.

The Association includes teachers and senior research workers in social anthropology in the British Empire. Membership is limited to persons holding, or having held, a teaching or research appointment in social anthropology, and is strictly by invitation of the officers and committee of the Association. The present officers and committee are: Prof. A. R. Radcliffe-Brown (president), Prof. E. E. Evans-Pritchard (chairman and hon. secretary), Prof. Raymond Firth, Prof. C. Daryll Forde and Dr. Meyer Fortes.

Iraq Natural History Museum

THE first Natural History Museum in Iraq, which is under the auspices of the Iraqi Ministry of Education, was established early in 1946. The formal opening by the Regent of Iraq took place on May 2, 1946. The Museum consists of three main departments at present. (1) Zoological Department: the present exhibits in this department represent most of the avifauna of Iraq, as well as small collections of Iraqi mammals, reptiles, fishes and invertebrates. (2) Botanical Department: in this department plaster models of Iraqi fruits and vegetables are exhibited. There are also specimens of plant products, economic plants, plant diseases, etc. (3) Geological Department: in this department two of the oil companies operating in the country have participated in presenting its exhibits. The Iraq Petroleum Co. presented a cement model of the geological structure of the Kirkuk oilfields, as well as specimens of rocks, crude oil, and fossils found in Iraq. The Rafidain Oil Co. presented a model of an oil refinery, specimens of oil products, a model of a Leyland motor oil-tanker, a lubricating oil unit, a petrol filling pump, and various photographs and diagrams. The Museum is seeking to establish contacts with similar museums elsewhere, and to exchange information and publications with them. All communications should be addressed to the Director, Iraq Natural History Museum, Baghdad, Iraq.

British Society for the History of Science

AT the first annual general meeting of the British Society for the History of Science, held in the rooms of the Royal Society on May 5, the following elections of officers and council were made: *President*, Dr. Charles Singer; *Vice-Presidents*, Prof. H. Dingle, Dr. E. J. Holmyard, Sir Arthur MacNalty, Prof. J. R. Partington, Mrs. Charles Singer, Dr. Sherwood

Taylor; *Hon. Secretary*, F. H. C. Butler; *Hon. Treasurer*, H. W. Robinson; *Council*, Dr. H. P. Bayon, Prof. G. R. de Beer, C. N. Bromehead, J. G. Crowther, Dr. Dorothy Feyer, Dr. S. Lilley, Dr. D. McKie, H. T. Pledge, Dr. H. Shaw, Dr. H. Hamshaw Thomas, Sir Henry Thomas and Dr. E. Ashworth Underwood. The address of the honorary secretary is: Ravensmead, Keston, Kent.

Colonial Medical Research Studentships

On the recommendation of the Colonial Medical Research Committee, the Secretary of State for the Colonies has instituted ten research studentships for graduates in medicine and cognate sciences, who desire by this means to prepare themselves for research work in tropical medicine and related subjects. The Studentships will carry an allowance at the rate of £260 per annum, and will normally be for a period of two years. They will be awarded on the advice of the Colonial Medical Research Committee, and will be tenable at any university or other appropriate institution as approved by the Committee. Candidates must be British subjects and graduates of British universities. Application should be made, through the head of the candidate's department, to the Secretary, Colonial Medical Research Committee, c/o Research Department, Colonial Office, London, S.W.1.

Textile Institute

The Textile Institute is offering a scholarship, under the terms of a grant from the Cotton Trade War Memorial Fund, to young craftsmen in the cotton spinning or weaving industry, and is planning an additional award for those who have not yet entered the industry. The scholarship will extend for not more than three years, and is of a maximum value of £200 prior to the final year, and £350 for the final year, during which it will provide the holder with practical experience abroad. Forms of application can be obtained from the General Secretary, Textile Institute, 16 St. Mary's Parsonage, Manchester 3; applications are to be made by July 1.

Prof. Fred Bradbury, formerly head of the Department of Textile Industries at Belfast College of Technology, has been elected to honorary life membership of the Textile Institute. Prof. Bradbury took part in the formation of the Institute thirty-seven years ago, and was a member of the Institute's first Council elected in 1910.

Congresses

International Congress on Short-Wave Therapeutics

An International Congress on Short-Wave Therapeutics will be held in Amsterdam during July 19–24, 1948. Formal papers followed by discussions are being arranged. Particulars can be obtained from the Secretary of the Congress, Weteringschans 73, Amsterdam.

International Congress on Engineering Education

Prof. Richard Vieweg and Prof. Alwin Walther, with a small group of staff of the Darmstadt Technische Hochschule, are now trying to rebuild the college both as regards its buildings and its standing. They are accordingly organising, with the approval of the American Military Government, an International Congress on Engineering Education, to be held at Darmstadt during July 31–August 9. Feeding and housing of conference members from outside Germany will be undertaken by the American quartermaster's school at Darmstadt; suitable provision will also be made for Allied visitors from the other occupation zones. Darmstadt Technische Hochschule and the city of Darmstadt will furnish accommodation for Germans who attend. The preliminary programme indicates the following topics for discussion: (1) technology as an ethical and cultural opportunity; (2) present state and trends of development in engineering education throughout the world; (3) admission of students in relation to social problems; (4) exchange of professional ideas. Further information can be obtained from the Rector, Technische Hochschule Darmstadt, Kongressleitung, Darmstadt, U.S. Zone, Germany.

Announcements

Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford and president of the Royal Society, has been awarded the Albert Medal of the Royal Society of Arts "for his outstanding contributions to the advancement of organic chemistry".

Under the Statute of the Royal Society which provides for the election of persons who either have rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society, Mr. Clement R. Attlee has been elected a fellow of the Society.

Dr. John B. M. Coppock, head of the Technical Development Laboratories of the Fine Chemical Department, Boots Pure Drug Co., Ltd., Nottingham, has been appointed director of research of the recently formed British Baking Industries' Research Association.

Dr. F. N. Woodward has been lent to the Department of Scientific and Industrial Research for appointment as director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office in Washington. The present director, Dr. Alexander King, is shortly returning to the United Kingdom to take up an official appointment. Dr. Woodward is at present director of the Scottish Seaweed Research Association; during the War he was on the scientific staffs of the Ministries of Supply and Production. Dr. Woodward will also act as attaché for scientific questions to the British Embassy in Washington.

The Council of the University of Sheffield has made the following appointments: G. L. Hermitte, to be lecturer in histology; F. T. Thorpe, to be lecturer in mental diseases; R. M. Haythornthwaite, to be lecturer in civil engineering.

Mr. J. G. Pearce, director of the British Cast Iron Research Association, writes to point out that in the article in *Nature* of May 10, p. 649, on the Birmingham conference of the Federation of British Industries, the last sentence of the remarks attributed to him may give rise to misunderstanding. The full text was: "Of the major functions of a research association, the creation of new knowledge by research, its application in a given case through development, and its dissemination by intelligence activities, the problems of development and dissemination have been least satisfactorily solved . . ."

Erratum. In the communication "Nucleotide Metabolism of Bacteria and the Bacterial Nucleus" in *Nature* of April 26, p. 577, the illustration was inadvertently printed upside down.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Atomic Mass of Silicon

As is well known, the atomic mass of silicon has not yet been determined with satisfactory accuracy. The value given in the International Table of Atomic Weights is 28·06. Practically the same value, 28·063, was given by Baxter, Weatherill and Scripture[1] in 1923 from the ratio $SiCl_4/4Ag$. But from the same ratio, figures of $28{\cdot}11_1$ had been obtained in 1920 by Baxter, Weatherill and Holmes[2] and of $28{\cdot}10_5$ by Hönigschmidt and Steinheil[3]. Finally, in 1923, Weatherill and Brundage[4], from the ratio $SiCl_4/SiO_2$, gave the value $28{\cdot}10_6$. The three of the four modern gravimetric values are in fair agreement and lead to a mean figure of $28{\cdot}10_6$, which exceeds by 1/610 approximately the figure given in the International Table. This difference, considering the precision of modern gravimetric methods, is too great to be accepted without reservations, and it makes desirable and urgent a further revision of the atomic mass of silicon.

For this reason the recent publication of the experiments carried out by E. P. Ney and McQueen[5] with the mass-spectrograph on the isotopes of silicon must be welcomed. Subjecting silicon fluoride to an electronic bombardment, several ions are produced, among which the group SiF_3^+ is particularly interesting, from which it was possible to measure the mass and the abundance of the three isotopes, ^{28}Si (92·24 ± 0·10); ^{29}Si (4·69 ± 0·05) and ^{30}Si (3·07 ± 0·05). From these data, Ney and McQueen give the value of the atomic mass of silicon as 28·087, exceeding by 1/1039 the figure accepted by the International Commission.

The revision of the atomic mass of silicon has been undertaken at the Laboratory of Physical Chemistry of Compostela (Spain) using the pykno-X-ray method. This method, applied for the first time by Hutchison and Johnston to the determination of the atomic mass of fluorine[6], is based on the comparison of the molecular mass of the substance with that of calcite. The molecular mass of a crystal depends on: (*a*) the volume of its unit cell; (*b*) the number of molecules contained in the latter; (*c*) its density (ρ); and (*d*) Avogadro's number (N_A); hence when these values are known—at a given temperature—for the substance and the calcite, a simple formula enables the atomic mass to be calculated.

The compound chosen for the revision of the atomic mass of silicon was silica (SiO_2), in the form of α-quartz of hexagonal structure, the X-ray constants of which accurately determined by A. H. Jay[7] at 18° C. are: $a = 4{\cdot}9029$ A., and $c = 5{\cdot}3933$ A. As regards density, the pykno-metric measurements at 0° C., carried out by C. Gutierrez Losa in this Laboratory using our precision technique[8] with very pure transparent quartz from Noya (Corunna, Spain) give the mean value: $\rho_4^0 = (2{\cdot}6506_8 \pm 0{\cdot}0002_3)$ gm./cm.^{3}. Taking as coefficient of cubic expansion of α-quartz[9] the value $3{\cdot}529 \times 10^{-5}$, the density of SiO_2 at 18° C. will be: $\rho_4^{18} = (2{\cdot}6490_0 \pm 0{\cdot}0002_3)$ gm./cm.^{3}. As regards calcite, I have taken as molecular mass, $M_{CaCO_3} = 100{\cdot}090$, and as density, grating space and geometric structural constant, $\varphi(\beta)$, at 18° C., the values given by Bearden and Bearden and Shaw[10]: $\rho_4^{18} = 2{\cdot}71036$ gm./cm.^{3}, $d^{18} = 3{\cdot}02945$ A., and $\varphi(\beta) = 1{\cdot}09598$.

From the equations,

$$M_{SiO_2} = \frac{\sqrt{3}}{6} \cdot N_A \cdot \rho_{SiO_2} \cdot a^2 \cdot c$$

and

$$M_{CaCO_3} = 2 \cdot N_A \cdot \rho_{CaCO_3} \cdot \varphi(\beta) \cdot d^3{}_{CaCO_3},$$

and expressing the molecular mass of SiO_2 and $CaCO_3$ as a function of the other magnitudes mentioned, we conclude

$$M_{SiO_2} = M_{CaCO_3} \cdot \frac{\sqrt{3}}{12} \cdot \frac{\rho_{SiO_2}}{\rho_{CaCO_3} \cdot \varphi(\beta)} \cdot \frac{a^2 \cdot c}{d^3{}_{CaCO_3}}.$$

Substituting in this equation the various numerical values, we find $M_{SiO_2} = 60{\cdot}075$, the atomic mass of silicon being, therefore,

$$Si = 28{\cdot}075.$$

This determination is based on the molecular mass of calcite. This may not be the best reference substance for our purpose, since "it is well known to crystallographers that calcite always contains impurities"[11], and also because in the value of its molecular mass there is an approximate error of ± 0·007. On this account it is advisable, in my opinion, to take as reference substance sodium chloride, the molecular mass, density and grating space of which have been accurately determined. From

$$M_{NaCl} = 2N_A \cdot \rho_{NaCl} \cdot d^3{}_{NaCl}$$

it can be deduced that

$$M_{SiO_2} = M_{NaCl} \cdot \frac{\sqrt{3}}{12} \cdot \frac{\rho_{SiO_2}}{\rho_{NaCl}} \cdot \frac{a^2 \cdot c}{d^3{}_{NaCl}}.$$

Taking as molecular mass, $M_{NaCl} = 58{\cdot}454$, as density, at 18° C., the figure given by Johnston and Hutchison[12], $\rho_4^{18} = 2{\cdot}16396$ gm./cm.^{3}, and as grating space, $d^{18} = 2{\cdot}81425$ A., and substituting these figures in the above equation, we obtain $M_{SiO_2} = 60{\cdot}076$, or $Si = 28{\cdot}076$, in good agreement with the figure obtained taking calcite as reference. The mean value of the two atomic masses thus found,

$$Si = 28{\cdot}075,$$

is somewhat lower than the value found by Ney and McQueen, but higher than the one accepted by the International Commission. The most recent determinations seem, therefore, to suggest that the atomic mass of silicon is slightly higher than the one still given in the International Table.

T. BATUECAS

Laboratory of Physical Chemistry,
University,
Santiago de Compostela, Spain.
March 7.

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[1] Baxter, Weatherill and Scripture, *Proc. Amer. Acad. Sci.*, **58**, 245 (1923).

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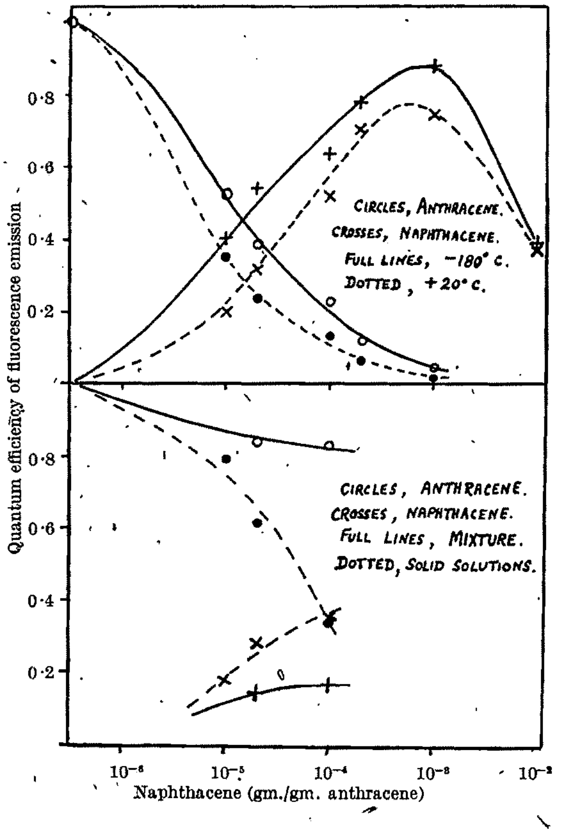
Fluorescence of Solid Anthracene

The fluorescence of solid anthracene in light of wave-length 3650 A. is changed from blue to green when very small quantities of naphthacene are present in solid solution. This is explicable by an 'exciton' mechanism whereby energy is handed on by resonance from molecule to molecule[1]. The graphs shown here represent a quantitative examination of the effect, the blue and green components of the fluorescence being measured by a photo-cell through Ilford filters 601 and 404 respectively. The upper graph shows for two temperatures the fall of the blue anthracene fluorescence and the rise of the green naphthacene fluorescence with concentration of the latter, expressed as quantum efficiencies with a probable error of 15 per cent. The emissions are about equal at a naphthacene concentration of 3 × 10^{-5}, and the green reaches a maximum at about 10^{-3}. Above this concentration the colour of the emission changes to yellow as for pure naphthacene, and the efficiency decreases, evidently due to the overstepping of the limits of solid solution.

The supposed 'exciton' effect cannot be due to direct light absorption by the naphthacene owing to its feeble absorption at 3650 A. To eliminate the possibility that re-absorption of blue anthracene fluorescence followed by re-emission as naphthacene fluorescence is the cause, solutions of anthracene and naphthacene in acetone were poured into aqueous gelatine solutions to produce milk-like sols, the fluorescence of which could be measured under conditions of feeble light absorption. The lower graph shows as dotted curves the blue and green intensities for anthracene – naphthacene sols precipitated from one solution. These do not differ greatly from the curves of the upper graph for solid solutions made by fusion. The full lines, however, relate to anthracene – naphthacene concentrations made by mixing separately prepared sols of pure anthracene and of anthracene – naphthacene mixtures of concentration 10^{-3}. The differences for homogeneous and non-homogeneous mixtures of similar composition are strong evidence in favour of the 'exciton' hypothesis.



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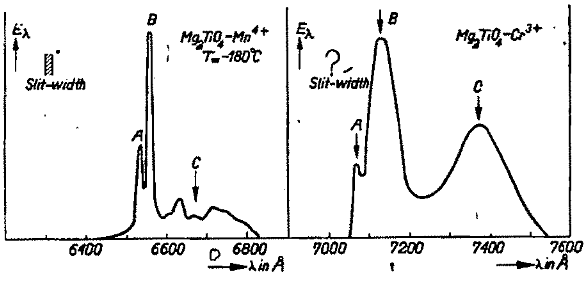
Tetravalent Manganese as an Activator in Luminescence

The fluorescence of luminophors activated with manganese, and also of pure manganese compounds, is generally attributed to divalent manganese[1]. The spectra emitted vary between green and red, and the width of the bands also varies from case to case, both probably being dependent on the magnitude and the symmetry of the electric lattice field at the position in the lattice at which the manganese ion is placed.

There is no doubt that this explanation is correct for the greater part of the manganese fluorescence known, and the colour differences between the green and red fluorescence respectively of zinc and magnesium silicates activated with manganese are certainly not due to differences in the valency of the manganese.

We have found some systems, however, in which also manganese of a higher valency can cause fluorescence. The emission due to these ions is situated in the red and shows a fine structure which is unusually sharp for manganese phosphors. In these systems, namely, zinc aluminate, magnesium aluminate, α- and β-aluminium oxide and magnesium titanate, all activated with manganese, the luminescence is markedly different according as the products are prepared under oxidizing or reducing conditions. The reduced products (except the titanate) show a green cathodo-luminescence. This emission is due to divalent manganese. The oxidized products show a deep red luminescence upon excitation by cathode rays or long-wave ultra-violet (3650 A.)[2]. This red fluorescence is due to manganese of a higher valency. In magnesium titanate the valency could be determined by chemical methods (titration), and was found to be between 3 and 4. That it is tetravalent manganese which is responsible for the red emission can further be proved by comparing the spectral distribution of the fluorescence of the salt when activated with manganese and with trivalent chromium respectively[3].



FLUORESCENCE SPECTRA OF Mg_2TiO_4—Cr^{3+} ACCORDING TO DEUTSCHBEIN (*loc. cit.*) AND Mg_2TiO_4—Mn^{4+}

The fluorescence spectra of these two substances (see graph) show a resemblance such as is to be expected for emissions which are characteristic of the iso-electronic ions Cr^{3+} and Mn^{4+} (both having a d^3 configuration) in the same surroundings[4].

Detailed results with these systems, including absorption, emission and excitation spectra, and the chemical methods used to obtain products with a maximum fraction of tetravalent manganese, will be published elsewhere[5].

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Feb. 21.

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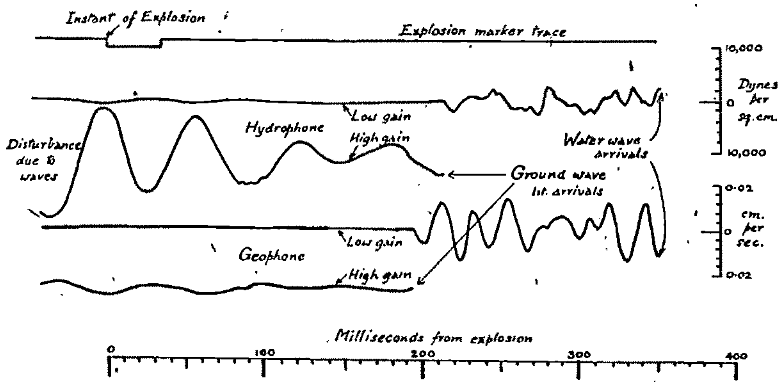
Marine Seismic Prospecting

In the years immediately preceding the War, considerable progress was made in the use at sea of the seismic method of studying submarine geology, and work was carried as far as the 100-fathom line. Further progress to deeper water was rendered difficult by the troubles arising in putting the instruments and explosives on the bottom of the sea. As a result of work in 1938 and 1939, it was suggested[1] that it might be possible to avoid these difficulties by having the instruments hanging in the water and relying on the transmission of the seismic waves from the bottom into the water. Unpublished observations during the War, both in Great Britain and in the United States, showed that seismic waves could, in fact, be observed in this way. In order to test the possibilities of the method, a direct comparison has been made of the signal received by a geophone on the bottom and by a hydrophone in the water. The explosive was also hanging in the water.

A calibrated moving-coil geophone, damped to give a constant velocity response from 30 to at least 100 c./s., was laid on the bottom with its axis approximately vertical. Its output was compared with that of a calibrated quartz-crystal hydrophone sensitive only to pressure changes, which was suspended about 40 ft. below the ship, and which had a flat response from 5 c./s. upwards.



RECORD SHOWING A COMPARISON BETWEEN THE SIGNALS PRODUCED BY A GEOPHONE AND A HYDROPHONE FROM THE SEISMIC WAVES RESULTING FROM AN UNDERWATER EXPLOSION

The output of each instrument was recorded at two levels of sensitivity, using four of the six strings of an Einthoven galvanometer. A fifth string was used to record the instant of explosion, so that the distance of the shot point could be determined from the transmission time of the direct wave through the water. Charges of 1–2 lb. of 'Polar Geobel', fired 100 ft. below the surface, gave satisfactory records up to 800 yards. A tracing from one of the records is shown in the figure. In this record the overall gain was adjusted so that the background-levels were visible on both high-gain strings, while the low-gain channels had about 24 db. less sensitivity. Under these conditions, the first arrival of the ground-wave was of sufficient amplitude to throw the high-gain strings off scale, while the direct water-wave produced a similar break in the low-gain traces. There was a considerable swell running when this record was taken, and the wind velocity was about 25 knots.

The charges used in the earlier experiments were attached to a buoy, fired by clockwork, and the instant of detonation transmitted to the ship by radio. This method was rendered cumbersome by the impossibility of controlling the instant of detonation after the buoy had been launched, and by the need for somewhat elaborate safety precautions. In most cases, therefore, the charge was trailed on an electric cable with floats every 100 yards. This method, while convenient at short ranges, could not easily be extended to distances greater than a few miles because of the labour of recovering the cable. For long-range work, it would be preferable to use a separate ship to fire the charge, as in the pre-war work, or to attach the hydrophone to a radio buoy which would transmit the signal back to the firing ship.

Difficulty arose from the transmission of mechanical disturbances down the instrument cables, but for the hydrophone this was overcome by giving the instrument a slight positive buoyancy, and by attaching a sinker about 30 ft. from the end of the cable. The geophone cable was similarly weighted, and the ship was allowed to drift freely during the recording period. Just before the shot, the geophone and weight were lowered to the bottom, and cable was paid out to allow for the movement of the ship. Under these conditions, the arrivals of the ground-wave were well defined, and the ratio of pressure to velocity agreed to within a factor of 2 with the theoretical value for plane waves in an infinite medium. Closer agreement was not to be expected, as the result was affected by reflexions from the surface, and by deviations of the geophone axis from the wave normal.

There seems no reason why this method should not be used in the deep ocean, and it appears to possess great practical advantages over any other that has been suggested.

The assistance of the Director of the Marine Biological Association at Plymouth for the laboratory and shipping facilities, and of the

Superintendent of the Admiralty Mining Establishment for the loan of the hydrophones and other apparatus, is gratefully acknowledged.

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A New Method for the Observation of Zones of Colourless Substances on a Chromatographic Column

When chromatographic adsorption analysis is used for colourless substances (or on strongly coloured adsorbents, for example, activated carbon) it is impossible to see the zones of the different solutes adsorbed on the column. Some special arrangement is then needed in order to be able to locate the zones. In principle, two methods are available: (1) no observation is made on the column, but instead the concentration of the solution leaving the column is followed in a small cell; (2) the positions of the zones on the column are determined by using some special physical or chemical properties of the solutes. The first method, which was introduced by Tiselius[1] and improved by Tiselius and me[2,3], has also the advantage that the separation between two adjacent zones is greater in the filtrate than on the column. However, in many cases it is of importance to follow the separation directly on the column, and a number of different arrangements have been proposed[4]. In most of these cases the solutes either are converted into coloured compounds by means of suitable reagents, or indicators are applied before or after the chromatogram is finished, or use is made of fluorescence methods. These methods are, however, limited in use and unsuitable when zones are in direct contact with each other.

The new procedure to be described can be applied quite generally. The zones are detected on the column by observing the changes in refractive index of the solution in contact with the particles of the adsorbent. It is quite clear that this can be followed by any method for the determination of refractive index which uses the total reflexion of light entering through the glass wall of the tube in which the adsorbent is packed.

One of the simplest arrangements for the observation is the following. A tube with rectangular cross-section is used for the adsorbent (Fig. 1). Such a tube can easily be made by clamping two glass windows against a U-shaped plate of metal. One of the windows is rather thick and has polished edges. If the adsorbent is observed at the proper angle (Fig. 1) from a suitable distance (*c.* 1 metre), the boundary of the region of total reflexion is easily seen, and its position depends on the refractive index of the solution wetting the glass. Its shape will, therefore, be as in Fig. 2*a* in the case of an ordinary chromatogram with separate zones, and as in Fig. 2*b* if frontal analysis or displacement development is used. With strongly coloured adsorbents it may sometimes be useful to place a strip of thin white paper between the adsorbent and the glass window.

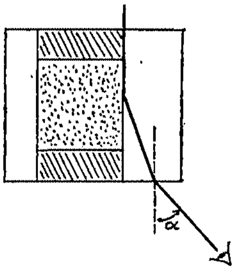

Fig. 1

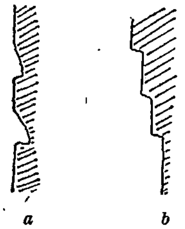

Fig. 2

Fig. 1. TUBE FOR CHROMATOGRAPHY SEEN FROM ABOVE
Fig. 2. SHAPE OF TOTAL REFLECTING REGION FOR (*a*) ELUTION ANALYSIS, (*b*) FRONTAL ANALYSIS

The operation of this method is in principle equivalent to that of a Pulfrich refractometer. It is clear that the sensitivity is improved by using monochromatic light during the observation. If necessary, the method can also be made quantitative by measuring the angle α with a telescope, since

$$n_0^2 - n_1^2 = \sin^2\alpha,$$

where n_0 is the refractive index of the glass and n_1 that of the solution. The accuracy can, of course, also be increased by using more elaborate methods for the observation; for example, an arrangement equivalent to a Hallwach's cuvette[5].

This method has the advantages that it can be applied quite generally and is independent of the specific properties of the solutes. Furthermore, it can be used when zones containing very similar substances with increasing concentration are in contact with each other, as in frontal analysis and displacement development. It seems also to be quite useful for inorganic chromatography. In the case of very large columns it is only necessary to place a strip of plane parallel glass in the wall of the container. It is also worth while to point out that different areas with different refractive indices can be detected in the same way when paper chromatography[6,7] is used, by placing the paper under the glass.

Although the method has the disadvantage that it is not so sensitive as most of the colour reactions, it does not exclude other kinds of observation, since the column can be observed in the usual way through the windows. Some experimental applications of the above principle will be reported later.

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Set Time and Particle Size

In dissolving high-molecular weight compounds in hydrocarbons to give viscous solutions, it is convenient to stir or otherwise agitate the mixture until the viscosity of the solvent is raised to such a degree as to prevent any settling of the partially dissolved particles on standing. After such a 'set time' is reached, the material can be left to dissolve on its own accord. Homogeneity may be attained by a final shaking or mixing.

Set time as described above is a complex phenomenon governed by several factors. However, it is possible to correlate set time and particle size by a simple functional equation on the assumption that the method of attaining solution is standardized.

For any particle, the representative dimension of which is L, the viscosity, μ, is given by

$$\mu \propto L^2,$$

where μ is the viscosity of the solution required to give a standard rate of settling of the swollen particle the original dimension of which was L. This expression still holds for set time, T, defined as the time when the rate of fall of the swollen particle reaches a low standard value, which is undetectable over a period of one minute by the naked eye.

The viscosity of the colloidal solution can be given by the approximate proportionality, connecting μ and C, the concentration :

$$\mu \propto C^n,$$

where n is a variable index approaching 1 at zero concentration and has been found to be as high as 8 at high concentrations of macromolecules in hydrocarbons. Thus :

$$C \propto \sqrt[n]{L^2}.$$

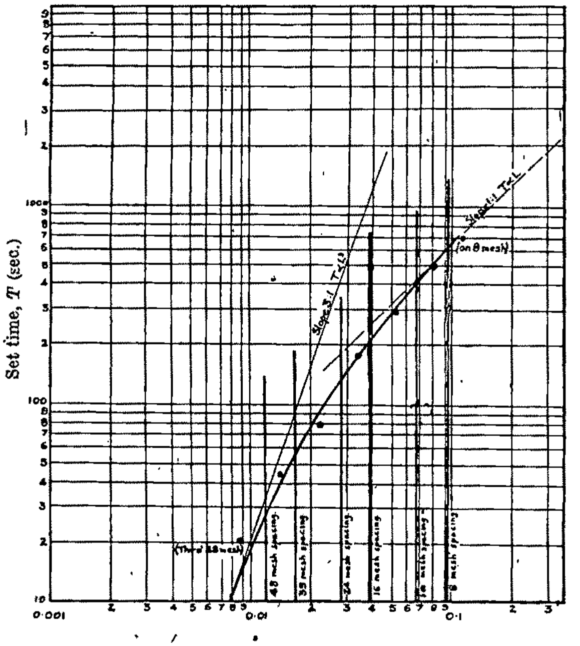
If the rate of solution, R, is approximately constant, due to stirring under standard conditions, then it is reasonable to put R as proportional to the specific surface of the particle per unit volume, that is,

$$R \propto 1/L.$$

Thus set time T will be reached when solution at the rate R yields a concentration C :

$$T = C/R \propto CL \propto L^{(1+2/n)}.$$

Thus for low concentrations ($n = 1$), T will be proportional to the cube of the representative dimension of the particle ; for high concentrations T is approaching a linear proportionality with L. As small particles require low values of C and large particles require high values, in order to be settling at undetectable rates, it follows that a plot of log T *vs.* log L should give a curve with log T varying with log L, so that $d(\log T)/d(\log L)$ is 3 at low values of L and unity at high values of L.



The accompanying graph gives the curve obtained for a series of sizes of a soap of aluminium. The agreement shown appears to justify the several assumptions made.

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Absorption of Hydrogen by Aluminium Attacked in Caustic Soda Solution

In some experiments reported recently by Moreau and Chaudron[1], it was found that prolonged immersion of high-purity aluminium in dilute ($N/100$) caustic soda solution resulted in the absorption of large quantities of hydrogen by the metal, and that the presence of this gas had a measurable effect upon the elastic modulus. After 20–30 days immersion, the hydrogen content, measured by an ion-bombardment extraction method, was found to be as high as 1,000 c.c. per 100 gm. of metal. This measurement was carried out on specimens turned down from the original corroded blocks, and the results would, therefore, indicate that the absorbed hydrogen had penetrated to a considerable depth in the metal.

Such behaviour on the part of aluminium would imply that it can exhibit a condition analogous to that of steel which has been embrittled by pickling in certain circumstances ; this, as is well known, is associated with the absorption of large quantities of hydrogen, which apparently segregates along cleavage planes and lattice imperfections, and has a very deleterious effect on mechanical properties. No phenomenon of this nature has been found in aluminium or its alloys ; but an appreciable uptake of hydrogen by a similar mechanism might have less obvious effects, and play an important part, for example, in corrosion, particularly under stress. The latter possibility has been suggested by Goldowski[2].

Since the experimental results quoted above are at variance with our own experience, we have carried out some tests in which the corrosive conditions were, so far as we can judge, identical with those described by Moreau and Chaudron ; but the hydrogen absorbed by the specimens was determined by a hot-extraction method[3]. In these tests, two specimens of cast 99·99 per cent aluminium, each weighing about 10 gm., were immersed in ($N/100$) caustic soda for 49 days, the solution being renewed at frequent intervals when the reaction appeared to be slowing down. The specimens each lost about half a gram in weight and were very deeply etched, especially at the grain boundaries. On removal from the solution they were washed in 1 per cent acetic acid and dried without handling. One specimen was degassed without any further treatment, and evolved hydrogen equivalent to 0·47 c.c./100 gm. of metal, and a much smaller volume of other gases, mainly carbon dioxide. The second specimen was skimmed to a depth of about 1 mm. on a lathe before degassing, and in this case the hydrogen content was found to be 0·43 c.c./100 gm., with a lesser volume of other gases than in the first experiment.

Other experiments indicate that with the latter treatment the bulk of the gases other than hydrogen, and about 0·05 c.c./100 gm. of the hydrogen itself, is associated with the oxide film which is inevitably present on the metal. The correction to obtain the true value of dissolved hydrogen is probably greater than this for the unturned specimen. We thus find that the hydrogen content of the corroded metal is rather less than 0·4 c.c./100 gm., with no evidence of a high concentration in the surface layers. A gas content of this order is quite normal for cast aluminium, and we therefore conclude that no appreciable absorption of hydrogen takes place under our conditions. We have certainly been unable to detect any effect of the magnitude described by Moreau and Chaudron.

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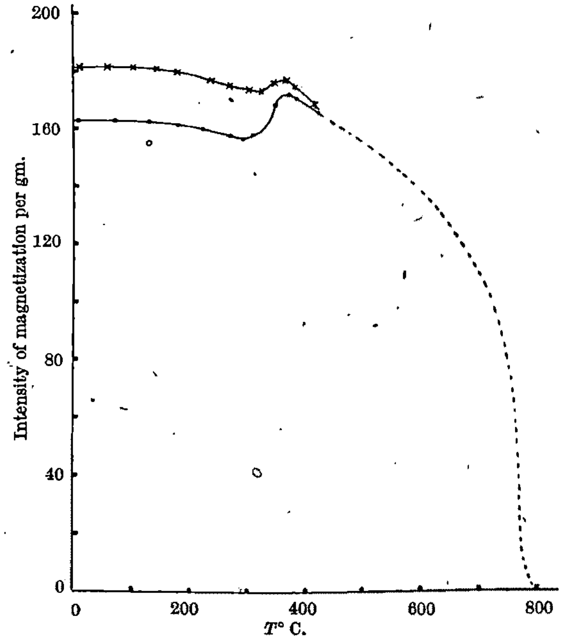
'Spoiling' of Tungsten Steel

It is known that the coercive force of tungsten magnet steel is reduced if the steel is maintained for a period at a temperature of 950–1,000° C. prior to hardening. The steel is then said to be 'spoiled'. In some such samples of tungsten steel the compound WC has been detected, and it has been suggested that the tungsten and carbon remaining in solution are insufficient to promote good hardening[1,2]. Experiments have been made on an unspoiled steel with the following analysis: W, 5·65; C, 0·72; Cr, 0·27; Si, 0·24; Mn, 0·3 per cent.



●—●, quenched from 850° C.
×——×, annealed at 950° C. for 64 hr. and quenched from 850° C.

Small samples of this steel were heated for various times in an enclosed quartz tube at 950° C. Later, while still in the tube, they were quenched from 850° C. in water. The intensities of magnetization of these samples were measured by means of a Sucksmith balance[3] at various temperatures. The field of 11,300 Oersted was sufficient to produce saturation. The figure shows curves of specific magnetization against temperature for two specimens treated in this way, the periods for which the specimens were kept at 950° C. being zero and 64 hours respectively. The specific magnetization of these specimens at room temperature after annealing in a region between 400° C. and 700° C. is always about 189.

The curves can be explained by assuming that the quenched specimens contain some austenite which is non-magnetic. On heating to 300° C., the austenite is transformed into a magnetic martensite or ferrite. (The change actually occurs slowly between 250° and 300° C., but the curves shown were taken with the temperature rising fairly rapidly, and consequently the transition appears at a slightly higher temperature.) The percentage of austenite can be estimated either (*a*) by assuming that it is proportional to the amount by which the specific magnetization at room temperature is less than that for a completely ferritic specimen, or (*b*) from the increase in the specific magnetization at 300° C. shown in the figure. Results using the two methods of estimation are shown in the table.

	Time at 950° C. (hr.)	σ	% of austenite	
			Method *a*	Method *b*
1	0	161·2	15	12
2	0	162·9	14	12
3	1	170·0	10·5	10
4	4	173·5	7	7
5	64	178·5	5	5

The percentage of retained austenite can be seen to decrease progressively as the time of annealing at 950° C. increases. To explain this result it may be assumed that at 950° C. tungsten and carbon combine to form a separate carbide phase, the reaction proceeding rather slowly and approaching equilibrium exponentially according to the law of mass action. The remaining solid solution becomes less rich in these elements, and since it is the presence of tungsten and carbon that enables austenite to be retained on quenching, the percentage of austenite retained will decrease as the amount of tungsten carbide increases.

The specimens were also examined microscopically, but it was not found possible to estimate the quantity of austenite by this method; but an increase in the patterns usually attributed to WC was observed as the time of annealing at 950° C. increased.

These experiments strengthen the theory that the 'spoiling' of tungsten magnet steel is caused by the formation of a separate carbide phase which reduces the amount of tungsten and carbon available to promote hardening.

We wish to acknowledge our thanks to the Permanent Magnet Association for permission to publish this note.

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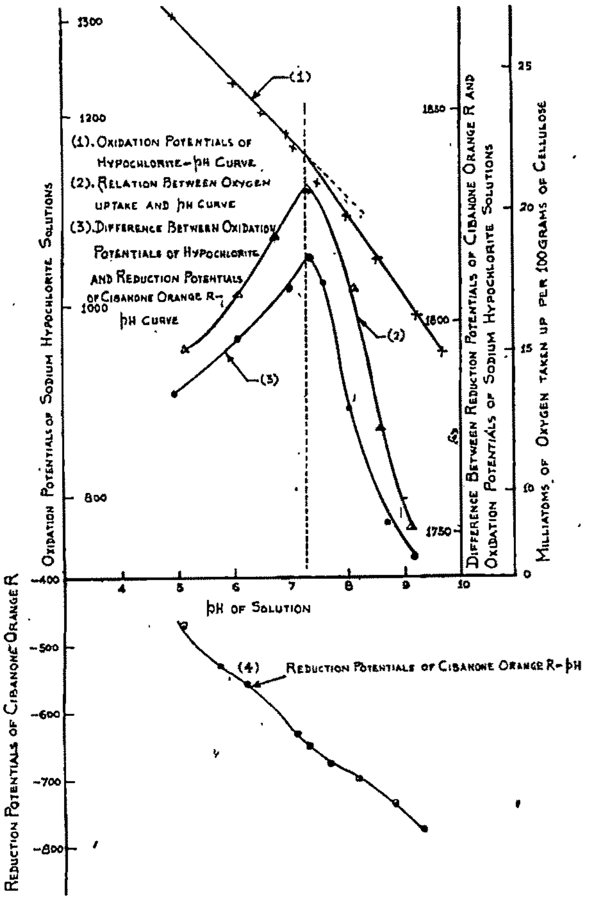
Accelerated Oxidation of Cotton Cellulose in Presence of Reduced Cibanone Orange R

THE rate of oxidation of cellulose by dilute solutions of sodium hypochlorite has been shown to be accelerated if certain vat dyes are also present in the reduced form upon the fibre[1,2]. Ferrous hydroxide precipitated on cellulose exerts a similar influence on the rate of oxidation[3]. The mechanism of this acceleration is not yet clear. It has been suggested[2] that the difference between the oxidation potential of the oxidizing agent and the reduction potential of the vat dye may be the determining factor in the acceleration of the oxidation. The present investigation deals with the measurement of reduction potentials of vat dyes upon the fibre and their influence on the acceleration of the rate of oxidation of the cellulose substrate by dilute sodium hypochlorite solutions.



Loose cotton dyed with Cibanone Orange R was tightly wrapped round a stout platinum wire. The dyestuff on the cotton was chemically reduced, and the free leuco compound was prepared by washing away the soluble impurities with oxygen-free distilled water. The electrode was then immersed in an oxygen-free buffer solution of known hydrogen ion concentration through which hydrogen gas was bubbled vigorously for fifteen minutes. The E.M.F. of the following cell was measured at short intervals:

+ Hg | Hg_2Cl_2,Sat.KCl || Sat.KCl || Leuco Cibanone Orange R dyed cotton in buffer solution | Pt −

The E.M.F. reached a constant value after about fifteen to twenty minutes and remained steady for periods varying between half to one hour. This constant value was taken as the E.M.F. of the cell. The potential of the half-cell

Pt | leuco Cibanone Orange R (dyed cotton in a buffer solution)

was calculated from the E.M.F. of the above cell. This value has been referred to as the reduction potential of Cibanone Orange R. The oxidation potentials of sodium hypochlorite solutions and the oxygen uptake by reduced Cibanone Orange R dyed cotton were measured by the method described by Nabar, Scholefield and Turner[3]. All measurements have been carried out at 30° C. The results are illustrated in the accompanying graphs.

It will be noted that the curve relating *p*H to oxygen uptake closely resembles the curve showing the relation between the *p*H and the difference between the oxidation potentials of hypochlorite solutions and the reduction potentials of Cibanone Orange R. A few other dyes examined show similar behaviour.

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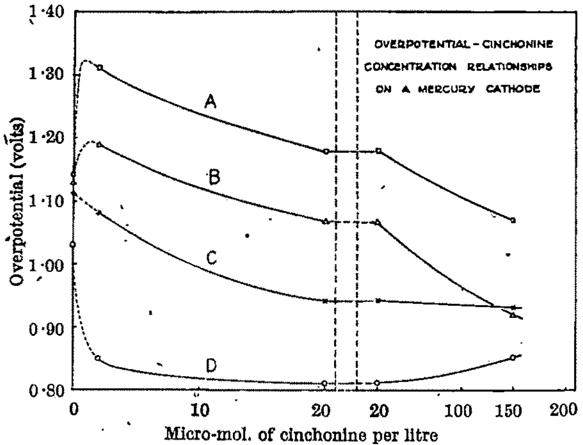
Effect of Alkaloids on Hydrogen Overpotential

IT is well known that certain substances, such as arsenious oxide[1], when added to a solution in which is a working electrode evolving hydrogen, considerably increase the hydrogen overpotential at the cathode. Such substances are often referred to as 'poisons'[2], and a detailed knowledge of their effects on irreversible electrode potentials appears to be of considerable importance in the elucidation of the mechanism of overpotential. It seemed probable that some additives might exist which function as 'activators' and thus decrease hydrogen overpotential at various current densities. Such substances have been found among certain alkaloids of the quinoline group.

Hydrogen overpotential has been measured by the direct method at current densities from 10^{-3} to 10^{-1} amp./sq.cm. on cathodes of mercury, lead, tungsten and platinized platinum in pure aqueous solutions of hydrogen chloride and in solutions containing quinoline, cinchonine, quinine, narcotine and morphine in concentrations from 2 to 150 micro-mol./litre. Marked lowering effects are observed in solutions containing these quantities of the alkaloids named above, particularly at lower current densities on mercury cathodes. Smaller lowering effects occur for lead; tungsten cathodes are little affected, and on platinized platinum all the above-mentioned alkaloids act as poisons.



A, 10^{-1} amp./sq. cm.; *C*, 10^{-2} amp./sq. cm.
B, 5×10^{-2} „ „ ; *D*, 10^{-3} „ „ .

Detailed results for mercury cathodes are given in the accompanying table, and a typical dependence of overpotential on concentration of alkaloid present is shown in the graph for mercury cathodes in solutions containing cinchonine.

EFFECT (APPROXIMATE) OF ALKALOIDS ON OVERPOTENTIAL ON MERCURY

Alkaloid		At 10^{-3}–10^{-2} amp./sq. cm.	Volts	At 10^{-2}–10^{-1} amp./sq. cm.	Volts
Quinoline	Lower conc.:	lowered	0·1	raised	0·1
	Higher conc.:	lowered	0·2	raised	0·2
Cinchonine	Lower conc.:	lowered	0·2	raised	0·1–0·2
	Higher conc.:	lowered	0·2	lowered	0·15–0·2
Quinine	Lower conc.:	lowered	0·2	raised	0·25
	Higher conc.:	lowered	0·1–0·2	raised	0·1–0·2
Narcotine	Lower conc.:	lowered	0·05	raised	0·1–0·2
	Higher conc.:	raised	0·05	raised	0·2–0·3
Morphine	Lower conc.:	lowered	0·05	raised	0·2
	Higher conc.:	raised	0·1	raised	0·3

The most notable features of the present results are that the lowering effects of the alkaloids increase with concentration at a given current density, and that they depend markedly upon the nature of the cathode material. Presence of alkaloid generally decreases the *b* factor of the Tafel equation[3] at low current densities and increases it at high current densities.

The results on mercury may be compared with the observations of Pech[4] and of Herasymenko and Slendyk[5] on the effects of alkaloids on the polarographic half-wave potentials, which were found to be changed by the presence of certain of these substances to more positive values.

The above work forms part of a comprehensive study of the effect of poisons on hydrogen overpotential which is being carried out in this Department. A detailed discussion will be published elsewhere.

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March 3.

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[1] Knorr and Schwarz, *Z. phys. Chem.*, **176**, 161 (1936).

[2] For example, see Hickling and Salt, *Trans. Farad. Soc.*, **37**, 333 (1941).

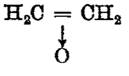
[3] Tafel, *Z. phys. Chem.*, **50**, 641 (1905).

[4] Pech, *Coll. Czech Chem. Comm.*, **6**, (3), 126 (1934).

[5] Herasymenko and Slendyk, *Coll. Czech Chem. Comm.*, **6**, (4–5), 204 (1934).

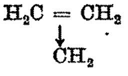
Structures of Ethylene Oxide and Cyclopropane

MY suggestion[1] that ethylene oxide and cyclopropane might be portrayed as (I)–(II) rather than (III)–(IV) has been criticized[2,3]. I wish, therefore, to discuss my suggestion, further.



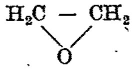
$$H_2C = CH_2 \atop {\downarrow \atop O}$$

(I)

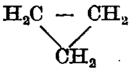


$$H_2C = CH_2 \atop {\downarrow \atop CH_2}$$

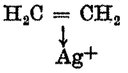
(II)



(III)

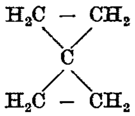


(IV)



$$H_2C = CH_2 \atop {\downarrow \atop Ag^+}$$

(V)



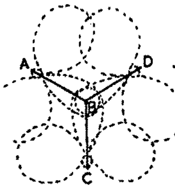
(VI)

My underlying ideas were: (1) evidence on olefinic donor properties suggests (I)–(II), just as (V) is known; (2) the carbon atoms involved are nearer the trigonal or ethylenic than tetrahedral state. Evidence for (2) seems very strong. (*a*) It is outstanding that epoxy or cyclopropyl groups joined to C=C show just those spectroscopic and chemical properties characterizing conjugation. Theory explains conjugation thus. All the carbon atoms involved are in the trigonal state: 2*p* atomic orbitals on neighbouring carbon atoms overlap to give a nonlocalized molecular orbital. The conjugation phenomena follow from the delocalization. Hence the idea that ethylene oxide and cyclopropane contain near-trigonal carbon atoms and molecular orbitals which, being built from 2*p* atomic orbitals, inevitably overlap with neighbouring 2*p* atomic orbitals. (*b*) The low dipole moment of cyclopropyl chloride: the high electronegativity of a trigonal carbon atom in its hybrid valencies[5], as in vinyl chloride, explains this. (*c*) The height of the strong CH Raman frequencies and the unsaturation properties of ethylene oxide and cyclopropane.

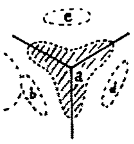
One is therefore led to structures with carbon atoms near the trigonal state. (I)–(II) suggest the existence of trigonal carbon atoms, non-localized orbitals, unsaturation, conjugating power. (III)–(IV) do not.

(I) suggests resemblance to amine oxides. Such is seen in work by Karrer[4], to which Sir Robert Robinson does not refer: certain epoxy groups *do* lose oxygen readily (→C=C). I do not suppose likeness between (I) and amine oxides to be *very* close: the orbital symmetries involved are so different. Similarly, analogy between (I) and (V) is not *very* close, for O, unlike Ag^+, has further valency orbitals which must be involved: their importance can be seen below.

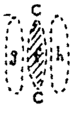
It is clear that the probable symmetry (from infrared data: *not* from intuition, which would suggest O_3 to be equilateral) of cyclopropane enforces superposition of three forms like (II). The resultant is not (IV), for it is still based on trigonal rather than tetrahedral carbon atoms. In the hybrid, the CH_2 planes must bisect the CCC angles: molecular orbitals are formed by overlap of (*a*) three hybrid sp^2 atomic orbitals, (*b*) 2*p* atomic orbitals. (VII) shows this: *AB*, *CB*, *DB* are CH_2 planes at 90° to the paper. The result has some of the character of (VIII). Two electrons occupy the three-pronged area *a*, two may be found either in *b* or *d* or *e*, and two lie in an orbital that represents a first overtone of *a*. The latter are 'anti-bonding' electrons: their presence reflects repulsion in (II) between the lone pair and other electrons. *b*, *d*, *e* are regions of high amplitude in an orbital with no actual nodes.



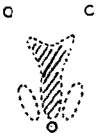
VII



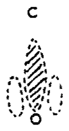
VIII



IX



X



XI

The resonance description of cyclopropane on my model is as a hybrid of three forms (II), the molecular orbital description partly as (VIII). The orbital pattern (VIII) to which we have been led is a generalization to three centres of the orbital picture (IX), which theory has evolved to explain two-centre unsaturation and make redundant the old distorted tetrahedral model for ethylene. *f* represents the σ, *g*–*h* the π orbital. (That (IX) and (VIII) *are* the same geometrical pattern applied to two and three centres respectively can be shown by folding filter papers along (i) two diameters at 90°, (ii) three at 60°, making the same cuts in each and opening out; *f* becomes *a*, *g*–*h* become *b*–*d*–*e*.) The molecular orbital picture for ethylene oxide is as (VIII), except that the dipole means *e* is now tenuous, *b*–*d* drawn downwards, the upper prongs contracted. (X) ensues. One reaches the same essential result[5] by considering the single structure (I) as the major resonance form. A >C=O group has the molecular orbital picture (XI). Some resemblance of ethylene oxide to CH_3CHO may therefore follow. Cationoid character comes from a large partial positive charge on the CC of (X), as on C of >C=O.

(VII) implies, besides (VIII), some localized-bond character. The overlap between any pair of $2p$ atomic orbitals is neither 'sideways' nor 'endwise'. So far as it is the latter, the resulting molecular orbital overlaps little with the third $2p$ atomic orbital, that is, localized bonds at *b*, *d*, *e* result, *a* is vacated and its component atomic orbitals, mixed with the original carbon atomic orbitals, cause some change towards tetrahedral atoms. The angle between the $2p$ axes is such that sideways overlap, with resulting non-localization, is greater than endwise—in accord with the carbon atoms being nearer trigonal than tetrahedral. In cyclobutane the angles are such that localization is greater and four-centre unsaturation less. Even in cyclohexane, however, a greater tendency (than in paraffins) towards $2p$ character in the C—C and of $2s$ in the C—H valencies is shown by CC weakness and CH strength[5].

In azoxy compounds, lone pairs and not bonding electrons are donated. This is not against (I), as ethylene has no lone pair. It is significant that azoxy groups do *not* form strained rings, though far less distortion of natural valency angles is necessary than in (I). A most important stable molecule to consider is spiropentane, usually drawn as (VI). My ideas are readily extended to this molecule, the central carbon atom being digonal and the two CCC planes at 90°.

Dr. McDowell's arguments seem not to affect my model. I do not expect (I)–(II) to show olefinic frequencies: the disturbance is too great for this. I *expect* S +—*R* to be able to replace NH or CH_2 or O.

So far as I can see, my model explains qualitatively all the salient facts. I think, therefore, (I)–(II) possible single formulæ, full descriptions (especially with (II)) needing hybridization with like forms; but if entirely new symbols for the binding at issue be suggested, I shall quite agree. I have been mainly concerned to apply wave mechanical principles to the problem—though Sir Robert Robinson apparently does not realize this. As regards co-ordination by bonding electrons, my contribution was to try to combine clear statement with a rational basis for assessing donation probability, namely, ionization potential knowledge.

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[1] Walsh, *Nature*, **159**, 165 (1947).

[2] Robinson, *Nature*, **159**, 400 (1947).

[3] McDowell, *Nature*, **159**, 508 (1947).

[4] Karrer, *Helv. Chim. Acta*, **28**, 474 (1945).

[5] Walsh, in course of publication.

Status of Potato Virus B

POTATO virus X is known to exist in many strains. Potato virus B has been considered to differ from all other strains of potato virus X, on account of its reactions on several potato varieties.

Clinch[1] considered 'Up-to-Date streak' to be synonymous with virus B of Bawden[2]. She was not certain whether a strain of X was present in her stock of Up-to-Date, along with the strain causing streak. However, it seems definite that Bawden's material contained a 'normal' X strain, as well as B in some plants at least.

Cockerham[3] described the reactions on several hosts, including a large number of potato varieties, of a virus from Duke of York potatoes. He considered this virus to be pure virus B. Bawden and Sheffield[4], working with this material, showed by cross-absorption tests that B and several strains of X were all serologically related but not identical. One of the X strains used (X^a) resembled B in some host reactions and not in others. They point out that a simple test based on host reactions is not a valid test of relationship.

'Up-to-Date streak' virus in Up-to-Date, supplied by Clinch, has been compared serologically with virus B from Bawden's source in Duke of York.

Rabbit antisera to the virus were prepared from the two sources. *Nicotiana glutinosa*, inoculated directly from potato, was used as the starting material for partially purified preparations of the virus free from tobacco mosaic. These preparations were used in absorption experiments. Cross-absorption tests, made with virus in slight excess, showed that both sources of the virus have an antigenic portion in common (7/8), and that each has a fraction distinct from the other (1/8 in each case), using the serum end-point as an estimate of the fractions.

It is concluded that virus B from Duke of York potato has an antigenic portion differing from the streak virus in Up-to-Date. The reverse is probably true. However, the possibility that part of, or all, this difference is caused by an X-type strain, present along with the streak strain in Clinch's material, has not been eliminated.

It is suggested that virus B is no more a single entity than is virus X. It is possible that many strains of virus X may be found which do not give top necrosis on varieties like Epicure and King Edward. This conclusion, together with the findings of Bawden and Sheffield[4], indicate that there is no sound basis for giving the strains known as 'virus B' any special status within the X group. There seems to be no good reason why the reactions on a few arbitrarily chosen varieties of potato (or any other single host) should have any special significance as a basis for the classification of X strains into groups.

The value of the cross-absorption figures as a quantitative estimate of the 'common' and 'non-common' portions on the particle is very doubtful. Nevertheless, carried out with a number of strains, it may give some indication of the relative extent of antigenic relationship.

My thanks are due to Dr. Phyllis Clinch and Mr. F. C. Bawden for supplies of their material, and to Dr. K. M. Smith and Dr. Roy Markham for helpful criticism.

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April 17.

[1] Clinch, Phyllis E. M., *Sci. Proc. Roy. Dublin Soc.*, **23**, 18 (1942).

[2] Bawden, F. C., *Ann. Appl. Biol.*, **23**, 487 (1936).

[3] Cockerham, G., *Ann. Appl. Biol.*, **30**, 338 (1943).

[4] Bawden, F. C., and Sheffield, F. M. L., *Ann. Appl. Biol.*, **31**, 33 (1944).

A Protozoal Disease of South African Trawled Fish and its Routine Detection by Fluorescence

Recent investigations into the problems of (*a*) 'mealiness' of the cooked flesh of the Cape John Dory (*Zeus capensis*) and (*b*) milky spots in smoked fillets of the stockfish (*Merlucius capensis*) have revealed that the abnormalities are a consequence of heavy infections of the muscle fibre by a protozoal parasite. The parasite is identical to that described by Gilchrist[1] as *Chloromyxum thyrsites* causing the 'pap' condition of the snoek (*Thyrsites atun*). Fantham[2], however, suggested that the organism might be identical to *Chloromyxum quadratum*, Thélohans.

Gilchrist reported that 5 per cent of the snoek catch were so heavily infected as to be of no commercial value, and that microscopic examination of the flesh of twelve fish selected at random and considered perfectly healthy revealed that eight of the fish were infected.

In the John Dory, approximately 25 per cent of the catch landed are extremely emaciated, with the flesh so soft that it cannot be filleted. It is just possible to detect less severe infection at the time the fish is landed by trawlers, by the greater opacity of the infected muscle fibres, while 36–48 hours later the infection is clearly visible as milky areas embedded in the flesh.

In the stockfish there are no visible signs of infection until after the fillets have been smoked, when the infected areas appear as whitish spots embedded in the flesh. The 'milky' spots, on pressing, exude an ooze of disintegrated tissue heavily impregnated with the characteristic spores of the parasite.

The discovery that infected muscle fibres fluoresce under ultra-violet light filtered through Wood's glass has made it possible to survey in large samples of the catch, (*a*) the distribution of infection within the tissues, (*b*) the intensity of infection, and (*c*) the number of fish infected. The infection is limited to single or a few adjacent muscle fibres distributed at random throughout the flesh. Such muscle fibres fluoresce brilliantly in the stockfish, and even deeply embedded infections can be detected without difficulty. In the John Dory, the intensity of the fluorescence is not so great, but is ample to indicate even a single infected fibre in the whole fish. The fluorescence is greatly diminished in salted fish.

The extent of the infection in the trawled fish may be gauged from the following data.

Fish	No. examined	% Infected
John Dory	596	76
Stockfish	660	70

The extent of the infection may vary from a single muscle fibre to a state in the John Dory in which the fluorescing fibres permeate the whole flesh. It is difficult to imagine how such fish can move and live. It is probable that only the numerous spines with which the John Dory is protected save the heavily infected individuals from becoming easy prey to other fish. Heavy infection of the order encountered in the John Dory has not been seen in the stockfish; but there is no clear evidence to indicate whether this is due to greater resistance or to the elimination of the fish as soon as the infection reaches moderate proportions, when muscular movement might be affected.

The John Dory catch is also characterized by the preponderance of female to male in the ratio of approximately 2 : 1. The distribution of the intensities of infection in male and female fish and the proportion of infected individuals among the sexes seems to indicate that the male fish are more susceptible and that the disease progresses more rapidly in the male. There is strong presumptive evidence of considerable mortality in the John Dory from this disease. It is of considerable interest that Gilchrist suggested in 1924 that the occasional meagreness of the annual shoals of snoek visiting the Cape could probably be ascribed to this disease.

Details of this investigation will be published elsewhere.

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E. Beyers

Low Temperature Research Laboratory,
Cape Town.
March 31.

[1] Gilchrist, J. D. F., *Trans. Roy. Soc. S. Africa*, **11**, 263 (1924).

[2] Fantham, H. B., *Proc. S. African Assoc. Adv. Sci.*, 346 (1925).

Population Studies in Fisheries Biology

G. L. Kesteven has stressed[1] the need for a dynamic approach to the study of fish populations. It has been possible recently to develop a mathematical treatment having certain features in common with that of Baronov[2], which bears this necessity in mind, and which we feel will be of value in further consideration of fisheries problems, and in particular has immediate application in the assessment of remedies for overfishing.

Russell's equation[3] expresses the dependence of the yield from a fishery on the vital coefficients of the population (natural mortality, recruitment and growth) and the rate of fishing. In its original form, this equation is not an analytical tool, as Kesteven points out. It is possible, however, to express these fundamental relationships in a form that would enable application to any population of fish for which there are sufficient data.

We shall define the primary factors that enter into a determination of the rate of yield, in terms of the coefficients of recruitment (B), growth ($W(t)$) and natural and fishing mortalities (M, F), M including a factor for loss by emigration from the area considered. All other factors, such as population density and mesh selection in so far as they influence the rate of yield, do so by virtue of their effect on these primary coefficients, and thus can be incorporated into the equations.

If B is equal to the number of fish attaining fishable size per year, and the coefficients are effective over a period λ years, the fishable life-span of the species, it can be shown that:

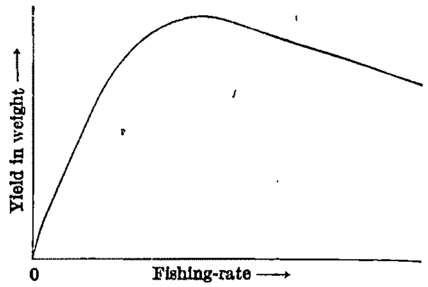
$$Y = \sum_{n=0}^{\lambda-1} \int_{t=n}^{n+1} W(t).F.B.\exp\left(-\int_0 F + M\right) dt,$$

where Y is the yield in weight per annum. It must be emphasized that this, and the following example, apply only to equilibrium condition.

To illustrate the form which the equation may take, we consider the simplest case, where B, M and F are constants, and $W(t) = \alpha + \beta t$.

$$\text{Then } Y = B.F. \int_0^{\lambda} (\alpha + \beta t) \exp(-(F + M)t)$$

$$= \frac{B.F}{F+M}\left[\alpha + \frac{\beta}{F+M} - \exp(-(F+M)\lambda \left(\alpha + \beta\lambda + \frac{\beta}{F+M}\right)\right]$$



There is a field in which this equation can be applied as a first approximation. A fuller treatment requires a determination both of the variable components affecting the primary coefficients and of the significance of possible departures from the steady state.

Further details of this procedure and its applications will appear elsewhere.

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[1] *Nature*, **159**, 10 (1947).

[2] Baronov, F., "On the Question of the Biological Basis of Fisheries" (Moscow, 1918).

[3] Russell, E. S., *J. Cons.*, **6** (1), 3 (1931).

Influence of the Medium on the Inactivation of Tetanus Toxin by X-Ray Irradiation

THE inactivation of diphtheria toxin by ultra-violet light was first demonstrated by Hertel[1] in 1904. This observation was fully confirmed by other workers for different toxins. Attempts to destroy toxins by means of irradiation with X-rays or radium have hitherto been unsuccessful. Only Ferroux and Muttermilch[2], using exceptionally large doses of radium and highly diluted tetanus toxin, reported destruction of the toxin.

Using considerably greater doses of X-rays than previous authors, we were able to inactivate tetanus toxin and to study the influence of the medium on toxin inactivation *in vitro* by X-rays. The influence of the medium on the destruction by X-rays of viruses, enzymes and other experimental material has already been demonstrated.

Material and Methods. We have used two types of tetanus toxin, prepared in different ways:

(1) A tetanus toxin prepared by culturing tetanus bacilli anaerobically for 14 days in meat infusion broth containing glucose, and afterwards purifying the product by Eaton's method[3]. Such a toxin sample contained 1,000 minimum lethal doses (M.L.D.) in 1 c.c., and yielded 0·14 mgm. nitrogen per 1 ml. in a micro-Kjeldahl test. It will be referred to as $T1$.

(2) The second tetanus toxin sample employed was prepared by culturing tetanus bacilli in Mueller's medium[4] and diluting the product so that it contained 1,000 M.L.D. per 1 ml. This yielded 4·5 mgm. nitrogen per ml. in the micro-Kjeldahl test. It will be referred to as $T2$.

Irradiations were carried out with an Ott tube operated at a tension of 35 kV. and a current of 5 m.amp. with a copper anticathode. The distance between the vessel in which the toxin was irradiated and the focal point was 50 mm., and the intensity of the X-rays was about 90,000 r./min. The window was aluminium foil 30 μ in thickness.

Samples of toxin (0·1 ml.) were irradiated in vials with a diameter of 15 mm., the depth of the liquid in the vials being 0·6 mm. After irradiation the treated toxin solutions were serially diluted to varying extents with saline. At least four white mice, averaging 20 gm. in weight, were inoculated with each of the toxin solutions. Unirradiated control samples of toxin were similarly treated.

The medium was varied by adding a series of proteins and peptones to samples of $T1$.

Results. A dose of 7 million r. suffices totally to destroy the 100 M.L.D. contained in 0·1 ml. of the original standard $T1$ sample, whereas lower dosages only partially inactivated the original 100 M.L.D. The extent of toxin inactivation was determined by the inoculation of varying dilutions of the irradiated original standard toxin sample. In this way it was found that a standard $T1$ sample, after exposure to 4 million r., contained 50 per cent (50 M.L.D.) of the toxin originally present. Doses of 3 million r. inactivated 20 per cent (20 M.L.D.) of the same toxin, and 2 million r. only 5 per cent (5 M.L.D.).

X-ray irradiation of tetanus toxin $T2$ proved to have a less marked effect. Doses of 7 million r. inactivated only 20 per cent of this toxin (20 M.L.D.); 3–5 million r. destroyed approximately 10 per cent (10 M.L.D.). This difference in behaviour between $T1$ and $T2$ is probably associated with the greater purity of tetanus toxin No. 1. W. Dale[5], working with enzymes irradiated *in vitro*, reported the 'protective' action of certain substances contained in the medium. Similar observations on the protective action of certain substances against X-irradiation have been reported earlier[6–8] for viruses and enzymes.

In order to determine the possible association of different proteins and protein peptones with the enhanced resistance to X-rays, we added a series of these substances to samples of *T*1 before irradiation. The addition of different substances to the medium diminished the X-ray effect on the toxin in varying degrees.

In a number of experiments in which albumin was added, it could be observed that 10 per cent of albumin in the medium completely blocked the inactivating effect of 4 million r. on tetanus toxin (*T*1). Lower albumin content had a less noticeable protective action, and 0·1 per cent of albumin no longer had any demonstrable protective action against irradiation with 4 million r.

Protective action was noted after the addition of albumin, albumin peptone, rabbit serum, protamine, and globulin-peptone. No protective action was induced by the addition of globulin, casein, casein peptone, gelatine, edestin and irradiated toxin.

It is to be noted that substances, such as gelatine, which have a protective effect on certain other test objects such as sperm and hormones, exhibited no protective action on tetanus toxin in our experience.

This investigation has been carried out with the aid of a grant from the British Empire Cancer Campaign.

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Department of Bacteriology,
A. BACK
L. HALBERSTAEDTER
Department of Radiobiology,
Hebrew University,
Jerusalem. Feb. 3.

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[1] Hertel, E., *Z. allgem. Physiol.*, **4**, 1 (1904).

[2] Ferroux, R., and Muttermilch, S., *C.R. Soc. Biol., Paris*, **93**, 608 (1926).

[3] Eaton, M. D., and Cronau, A., *J. Bact.*, **36**, 423 (1938).

[4] Mueller, H. J., and Miller, J., *J. Bact.*, **43**, 763 (1942).

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[6] Lacassagne, A., and Nyka, W., *C.R. Soc. Biol., Paris*, **128**, 1038 (1938).

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Value of Adding Cotton-Seed, Okra and Fenugreek to Maize Flour

THE association of maize-eating with pellagra and the prevalence of this disease in Egypt have, from time to time, suggested the replacement of maize by some other flour in bread-making; this being impracticable, attempts have been made to raise the nutritive value of maize by supplementing it with other flours. In Egypt, the problem has been unintentionally solved by peasants who have adopted the addition of either fenugreek (*Trigonella Fœnum-græcum* L.), or okra (*Hibiscus esculentus* L.) to maize flour. The resulting bread was very satisfactory, at least so far as added fenugreek is concerned, and it compared well with wheaten bread.

It occurred, however, to those interested in cotton-seed by-products to recover the proteins of the seed after the extraction of the oil and to use the resulting flour as a supplement to maize. The cotton-seed flour is a fine product with yellow-green colour and no particular odour or taste. Its reaction is acid, and it contains 8·75 per cent of moisture, 5·91 per cent of fat, 51·35 per cent of raw proteins, 4·11 per cent of raw fibres, 8·62 per cent of ash and 21·26 per cent of nitrogen-free soluble substances.

Supplementary value of the seed proteins. Unlike wheat, maize flour does not possess the sticky gluten which characterizes wheat. The Egyptian peasant's idea in adding fenugreek to maize flour probably aims at producing a more or less cohesive mass with the help of fenugreek mucilage. When fenugreek is scarce or when it is expensive, the peasants employ instead okra, which contains a similar mucilage. Both fenugreek and okra are local products and are very cheap in comparison with the cotton-seed flour.

It therefore appeared desirable to compare the nutritive value of maize to which cotton-seed flour is added with maize plus fenugreek or okra. Young growing rats were used as experimental animals. Fed as a supplement to a maize diet adequate in all respects except for its protein component, cotton-seed flour at a 4 per cent level enhanced growth in a similar way to that induced by fenugreek or okra supplement at the same level. The increments obtained were 13, 34, 25 and 32 gm. for the basal diet, the basal plus cotton-seed flour, plus fenugreek and plus okra respectively. It might be argued that cotton-seed flour is not bitter, and that unlike fenugreek more of it can be added to maize with impunity. Such addition may increase the nutritive value of the bread and be a point in favour of the cotton-seed flour. It will be remembered, however, that while the bitter taste of fenugreek restricts its use, there are no such restrictions in the case of okra. It was therefore decided to make a fresh comparison with higher supplements of these seeds. Diets of the same compositions but containing 10 per cent of the different supplements were employed, using again young growing rats. When the level was raised to 10 per cent, it was found that the biggest increment was obtained in the case of the okra supplement (77 gm.), then came fenugreek (72 gm.), and finally the cotton-seed flour (48 gm.). If the different supplements were compared by dividing the weight increase by the protein content of the supplement in the different diets (proteins of cotton-seed flour, 51 per cent; fenugreek, 23 per cent; and okra, 18 per cent), then at both the 4 per cent and the 10 per cent levels the protein value of fenugreek is 2·5 times that of cotton-seed flour, while okra is 1·5 times that of fenugreek.

Vitamin content of cotton-seed flour. Biological experiments were made to test for the presence of vitamin B_1 and nicotinic acid, while vitamin A and its precursor carotene were determined spectrophotometrically. Cotton-seed flour contains an amount of vitamin B_1 equivalent to a fifth of that present in an equal weight of a sample of fresh 'Marmite'. The ether-soluble extract of the flour was examined spectrophotometrically and was found to contain no vitamin A, but it contained on the average 6·375 mgm. of carotenoids per cent. As regards nicotinic acid (anti-pellagra and anti-blacktongue factor), feeding experiments with dogs showed that it contained a small amount.

Cotton-seed flour is therefore inferior to fenugreek and okra in its protein value, and the vitamin content is not appreciable.

M. M. TAHA EL-KATIB
Faculty of Agriculture,
Fouad I University,
Cairo.
March 29.

PARTICLE SIZE ANALYSIS

PARTICULATE material is a general descriptive title for the many forms of matter existing in a state of sub-division into discrete particles. Such materials play an important part in almost all human activities, either as dust particles formed by natural agencies, or as powders produced by the artificial reduction in size of larger fragments of material. Dust is always present in the atmosphere, and though generally regarded as a nuisance, also fulfils useful purposes; but when present in excessive quantities it becomes a menace to health, and much active research is in progress to minimize the harmful effects of dust in mining and industrial atmospheres. Artificially ground powders are of the greatest importance to industry; sometimes their production is the main objective, as in the manufacture of Portland cement or pigments, and fine grinding of immense tonnages is an essential stage in the reduction of metallic ores. The building industry uses large quantities of materials in powdered or granular form, and a knowledge of the size analyses of these is essential. Agriculture and civil engineering are concerned with problems such as soil erosion, silt deposition and the foundations of buildings, for which data on the size characteristics of sedimentary deposits are needed. Thus there can be few manufacturing processes which are not dependent upon the use of powdered materials at some stage, and though the quantities involved may be smaller than in the industries mentioned above, the monetary value may be high, as for example in the fabrication of parts from metal powders.

Empirical methods of examination combined with the results of experience have in the past sufficed to determine the quality and the suitability of a powder for a particular industrial purpose, but for the last twenty years considerable attention has been given to methods of particle-size determination. During this period the literature on the subject has grown rapidly in volume; indeed this abundance is somewhat confusing to those commencing a study of methods of particle-size analysis.

A conference was held on February 4 by the Institution of Chemical Engineers and the Society of Chemical Industry (Road and Building Materials Section) with the object of clarifying this situation and summarizing the results of recent researches. The interest in the subject was even greater than expected, for out of an attendance of about 350 persons, quite a large number were unfortunately unable to gain admission to the meeting hall. The conference was divided into morning and afternoon sessions; at the morning session there were six papers dealing with methods of size analysis, and at the afternoon session five papers dealing with industrial applications of sizing analyses, all presented in abstract*. The authors were selected from research workers in Government or Government-aided research laboratories, universities and industrial research departments particularly concerned in the subject. Although clearly impossible to cover every aspect, the papers presented a cross-section of recent developments in particle-size measurement and typical industrial applications. The chairman of the morning session was Mr. Hugh Griffiths, president of the Institution of Chemical Engineers, and the discussion was opened by Dr. Idris Jones, director general of research for the National Coal Board. Dr. Jones directed attention to the importance of particle-size measurements in the coal industry, and emphasized the need for a study of dust-sampling methods. He especially stressed the need for developing a rapid method of size analysis, otherwise there were long delays in applying research to urgent industrial problems.

Dr. L. H. Lampitt, president of the Society of Chemical Industry, took the chair at the afternoon session, and opened the discussion by directing attention to the many applications of particle-size analysis in the food industry. Some thirty speakers contributed to the discussion during the day; many of the comments referred to technical points of detail which will be very helpful in developing research on the subject; but the problem of simplifying the situation for the newcomer to this field of study was scarcely touched. There appear to be three methods that are most promising for the routine measurement of the fineness or state of sub-division of a powdered material. These are the adsorption method of determining surface area, the permeability to fluid flow as a measure of external surface area, and the light-extinction or turbidimeter method of determining particle-size distribution and surface area. The three methods measure different properties of the powder, however, and several speakers directed attention to the need for a co-operative research which would delineate the characteristics of these methods of examination and enable some correlation of the results to be made. This could be done by a comprehensive series of tests on materials of particular importance to industry, and is clearly a subject for future research. The problem of standardization was not dealt with specifically in the discussion; although the British Standards Institution is now engaged in the preparation of standards for the size analysis of certain materials, an extension to cover powdered materials in general would be of great benefit to industrial research workers.

Prominence was given in several of the papers to the definition of terms, with particular reference to aggregates of particles. Much research on the measurement of particle size has been conducted on the assumption that the particles are individual or discrete entities of crystalline nature; indeed, the dispersal of a sample of powder into such a state is one of the problems of analysis. In many practical applications of powdered materials, however, the individual particles are often clustered together in aggregates known as 'working' or 'operational units' which are not physically constant, for the state of aggregation depends on the treatment to which the powder is subjected; for example, it will be different in the dry and wet states, though other factors exert considerable influence. Future research must be devoted to a study of these aggregates and to methods of measurement which indicate the size of these as well as of the discrete particles composing them.

The determination of particle-size analysis is an essential preliminary to the study of many industrial problems involving particulate materials, and much research has been hindered or even wasted by insufficient or incorrect knowledge of this factor. Thus, research on the theory of grinding or on the efficiency of commercial dust filters cannot progress without a knowledge of the size analysis of the materials concerned; and fundamental research on these and many other subjects is impossible until consistent and rapid methods of size analysis have been developed.

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* The authors of papers were as follows:

Methods of Measurement: C. N. Davies (Industrial Health Research Board, Medical Research Council); Dr. S. J. Gregg (University College, Exeter); Dr. H. Heywood (Imperial College of Science and Technology, London); Dr. F. M. Lea and R. W. Nurse (Building Research Station); Dr. D. G. Skinner and Dr. S. Boas-Traube (British Colliery Owners' Research Association); W. H. Walton (Chemical Defence Experimental Station, Porton).

Industrial Applications: Dr. A. C. C. Newman (Paint Research Station); Dr. R. K. Schofield and Dr. E. W. Russell (Rothamsted Experimental Station); Dr. M. L. Smith (Philips Lamps, Ltd.); C. J. Stairmand (Imperial Chemical Industries, Ltd.); H. Whipp and F. W. Bernhardt (Dussek Bitumen and Taroleum, Ltd.).

This conference was the first of a public nature to be held in Great Britain to consider the properties of powdered materials, and marks an important advance in the study of this branch of applied science. The complete set of papers and the ensuing discussion, both at the meeting and in writing, should become a valuable source of reference on the subject for many years.

HAROLD HEYWOOD

SOCIETY FOR EXPERIMENTAL BIOLOGY

CONFERENCE IN UTRECHT

At the suggestion of Prof. G. J. van Oordt, the Society for Experimental Biology was invited by the botanists and zoologists of the University of Utrecht to hold a conference there during April 11–14. This was a memorable event in the history of the Society, being the first occasion on which a meeting had been held outside Great Britain. Utrecht and its ancient University have been for long associated with the struggle for the freedom of thought in Europe, and, after the recent relief from a period of intellectual suppression, it was a peculiarly happy environment for scientific discussion.

The response to the invitation was much greater than was expected, and the conference was attended by more than eighty members of the Society and about forty biologists from Holland, as well as a few from Belgium. As usual, there were separate botanical and zoological sessions, one in the Botanical Laboratory which, with the adjacent Botanical Gardens, is directed by Prof. V. J. Koningsberger, the other in the Zoological Laboratory, the two main sections of which, devoted to experimental embryology and to endocrinology, are under the direction of Prof. C. P. Raven and Prof. G. J. van Oordt respectively.

Some fifty-five papers were read which covered a wide field, though many centred around subjects upon which active research is now in progress in Holland—phytohormones, absorption of substances by plants, growth and differentiation of animal tissues, and comparative physiology. During a discussion on the possible influence of phytohormones on the fine molecular structure of the plasma membrane, we learnt that the deficiencies in Holland's war-time diet had prevented the secretion into the urine of auxin-*a*, for which the botanists at Utrecht had therefore been compelled to substitute indolyl acetic acid in their experiments on plant growth. Among other interesting subjects discussed in the Botanical Section were the absorption and transport of ions and the influence on this of illumination, the structure of the cell wall, apogamy in ferns and a quantum interpretation of certain data on phototropism. The Zoological Section devoted a morning to tissue differentiation, beginning with the development of bone and widening out into a general discussion on cellular differentiation. Another set of papers on neurophysiology, mostly of vertebrates, but including one on sea anemones, also provided material for good discussion. The rest of the papers were not so closely interrelated, but it was generally agreed that the meetings were stimulating and led afterwards to much informal discussion of these and other subjects of mutual interest to Dutch and British biologists. All communications were read in English and, to our great admiration, the proceedings were in no way hampered by the fact that our hosts were speaking a language in which they have had little practice in recent years.

During the afternoon of April 12, four of the University's Institutes showed demonstrations illustrating their current research. In the Botanical Institute were demonstrations of microdissection, of micro-chemical methods and of hormone test technique. In the Physical Laboratory (director, Prof. J. W. M. Milatz) is a biophysical research group working chiefly on problems connected with micro-organisms and photosynthesis, and here we were also privileged to see one of the few surviving original van Leeuwenhoek microscopes in an interesting demonstration of the history of microscopy. Work on experimental embryology and endocrinology was shown in the Zoological Laboratory; and in the Institute of Comparative Physiology, built in 1936 for the late Prof. Jordan with the aid of the Rockefeller Foundation, the research illustrated was mainly concerned with digestion and with the physiology of invertebrate muscle. This was the only occasion on which members of the Society experienced anything approaching disappointment as, owing to the excellence, number and geographical dispersion of the demonstrations, many were unable to see as much as they would have liked, though this was unavoidable.

The general organisation of the Conference and of its subsidiary functions was excellent, and for this we have to thank the local secretary, Mr. J. C. van de Kamer. In the evening of April 11 the delegates were received in the Central Museum by Dr. G. A. W. ter Pelkwijk, Lord Mayor of Utrecht and curator of the University, and by the director of the Museum, Jonkvr. Dr. C. H. de Jonge; and on the following evening there was a reception in the University by the president-curator, Jhr. Dr. L. H. Bosch Ridder van Rosenthal, followed by a chamber music concert by "The Society for Old Music" of works by Purcell and de Fesch. On Sunday, April 13, we were the guests of the Dutch Government in an excursion through North Holland to the Zuider Zee Dyke, and one of the chief engineers, Jr. Volker, and Mr. Botermans from the Governmental Department of Information, kindly acted as guides and explained some of the hydrological and biological problems connected with land reclamation.

By the generous invitation of one of the students' committees of the University of Utrecht, members of the conference were permitted to use as meeting-places and restaurants one of the clubs of the Utrechtsch Studentencorps, and a club of the Utrechtsch Vrouwelyke Studenten Vereeniging. This not only added greatly to the comfort and enjoyment of the proceedings, but also enabled us to understand how the Dutch have successfully solved the problem of a traditional corporate life in a non-residential university. But it must be especially emphasized that nearly all the eighty members of the conference were lodged and entertained in the homes of the University staff and of other professional people in the neighbourhood. In the present very difficult circumstances this is hospitality indeed; and one of the most significant features of the conference was the open hearted demonstration of personal and informa friendship which made the occasion one of much more than purely scientific value. This kind of atmosphere is perhaps less easily created at an ordinary international conference, and we hope that this will not be the last occasion on which a scientific society is invited to hold a meeting in another country.

L. C. BEADLE

MOUNT HOPE AND ITS DAIRY CATTLE

THE increase of milk production is one of the desiderata that is commonly accepted as necessary, and one of the equally commonly accepted ways of securing an increase is by the use of a proven sire. This is the more necessary because it has been said by no less an authority than Robert Boutflour that the average production during a lactation is little, if any, more to-day than it has been for a very long time.

It is to this end that the Mount Hope Farm was established, and a complex of investigations into the laws of inheritance among mice, poultry and dairy cattle began. Mr. Parmalee Prentice has now described these investigations (*Agric. History*, Oct. 1946). The work with dairy cattle started in 1916 when the first were bought, but contagious abortion delayed the start of real work on breeding until the herd had been purged of this disease, by which time (1924) a young Guernsey herd had been acquired which was thought likely to be good. For various causes a satisfactory bull did not appear, and in 1925 a bull was bought because he ranked well according to the system of valuing dairy bulls developed at the Maine Agricultural Experiment Station. This system is based on a comparison of a bull's mates and of his daughters; if the daughters' milk yield was higher the bull was advantageous, if lower the bull was detrimental. The amount of the increase was considered to be a measure of the bull's influence on milk yield.

Misfortune followed the choice, for the bull became impotent and a new bull was selected on the Turner measure for proven sires; but this was found unsatisfactory, and this particular system is no longer used "because it has been found that it over-estimated the inheritance which the sire contributed to its offspring"; and Mr. Parmalee Prentice and his coworkers found it conceivable that the daughters of this bull were good "not only because his influence was good but also because their dams had contributed as much as the sire"—which seems not unreasonable.

They then proceeded to work out a system of their own which they named the Mount Hope 'index', "a correct method of determining a bull's breeding worth from his daughters' records after allowance is made for the dam's influence upon the daughters' productivity". The index was first announced in 1927 and has now been before the world for twenty years.

"Bull indexes are computed by comparing the production records of the daughters and mates of the bull. In order to compare the production of the daughters with the production of their dams and to make comparisons between other cows of different ages, our statistics of milk production since 1936 . . . are always in terms of the mature equivalent. The index is then always applied to a comparatively small number of dam-daughter pairs. Moreover seasons vary; food and management are different in different barns and frequently change in the same barn. The physical condition of the cattle varies, and the result of it all is that though we are able with assurance to tell a good cow from a poor one and in general to tell how good a particular cow is, we are never able in measuring production records to tell with scientific precision the productive ability of a particular cow."

In many places the Mount Hope index has been accepted and is being used. In others, and perhaps the majority, the index is regarded with some scepticism. The need for proven sires and the sons of proven sires in dairy cattle breeding is fairly generally accepted, and records have been adopted so that performance may rank alongside 'pedigree'—one of the qualifications of which the Mount Hope workers are most critical. There has been a good deal of controversy about the Mount Hope dairy cattle and the Mount Hope index, and the essay by Mr. Parmalee Prentice in *Agricultural History* of October 1946 tells the whole story of the work that has been done there. The quarterly is the organ of the American Agricultural History Society, the offices of which are at Room 3870, South Agricultural Building, Washington 25, D.C.; and the annual subscription is four dollars.

G. E. FUSSELL

RELEASE OF INFORMATION ON ATOMIC ENERGY*

THE National Research Council of Canada is making available a number of reports, recently taken off the secret list, on subjects in the fields of theoretical physics and applied mathematics. These reports, which are either too long for journals or are summaries of other work, will be reproduced by the multilith process and will be available at a small charge from the Plans and Publications Section of the National Research Council, Ottawa.

Much material in the hands of the Council is being published in Canadian scientific journals, but the titles mentioned below represent a few which for special reasons cannot be dealt with in that way.

LIST OF DECLASSIFIED REPORTS

MT-1	The Functions $E_n(x) = \int_1^\infty e^{-xu}u^{-n}dx$	G. Placzek
MT-12	Elementary Approximation in the Theory of Neutron Diffusion	P. R. Wallace and J. LeCaine
MT-4	Notes on Diffusion of Neutrons without Change in Energy	G. Placzek and G. Volkoff
MT-131	A Table of Integrals involving $E_n(x) = \int_1^\infty e^{-xu}u^{-n}du$	J. LeCaine
MT-88	Influence of a Small Black Sphere upon the Neutron Density in an Infinite Non-Capturing Medium	B. Davison
MT-232	Influence of an Air Gap surrounding a Small Black Sphere upon the Linear Extrapolation Length of the Neutron Density in the Surrounding Medium	B. Davison
MT-93	Influence of a Large Black Sphere upon the Neutron Density in an Infinite Non-Capturing Medium	B. Davison
MT-112	Angular Distribution due to an Isotropic Point Source and Spherically Symmetrical Eigen-Solutions of the Transport Equation	B. Davison
MT-135	Influence of a Large Black Cylinder upon the Neutron Density in an Infinite Non-Capturing Medium	B. Davison
MT-124	Large Spherical Hole in a Slightly Capturing Medium	B. Davison
MT-136	Neutron Density at the Centre of a Small Spherical Cavity	B. Davison

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* British declassified reports are announced in *Nature*, March 22, p. 411.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Tuesday, May 27

University College (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Maurice Caullery: "Marine Biology on the French Coast in the Last Hundred Years".*

Wednesday, May 28

Institute of Fuel (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. E. A. Watson and Dr. J. S. Clarke: "Combustion and Combustion Equipment for Gas Turbines".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 5 p.m.—Sir Harold Spencer Jones, F.R.S.: "Modern Astronomical Instruments" (Trueman Wood Lecture).

Society of Chemical Industry, Chemical Engineering Group (at the Waldorf Hotel, Aldwych, London, W.C.2), at 5.30 p.m.—Annual General Meeting.

Institution of Electrical Engineers, London Students' Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Annual General Meeting.

Thursday, May 29

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. M. S. Bartlett: "Multivariate Analysis".

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. J. K. Northrop: The Thirty-fifth Wilbur Wright Memorial Lecture.

Television Society (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Dr. D. Starkie: "Plastic Lenses in Television Projection".

Friday, May 30

Physical Society (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5 p.m.—Scientific Papers.

Saturday, May 31

British Psychological Society (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 10.30 a.m.—"The Film in Education".

Tuesday, May 27—Saturday, May 31

Textile Institute (at Portrush, Co. Antrim).—Annual Conference. "Developments in the Production and Processing of Textiles."

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physical Chemistry, a Lecturer in Pharmaceutical Chemistry, a Lecturer in Metallurgy, a Lecturer in Physics, and a Lecturer in Biology—The Registrar, College of Technology, The Newarke, Leicester (May 31).

Senior Assistant in the Mechanical Engineering Department, and a Lecturer in Mathematics and Physics, at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (May 31).

Lecturer in Chemistry and Metallurgy—The Registrar, Technical College, Sunderland (May 31).

Chair of Physiological Chemistry—The Secretary of the University Court, The University, Glasgow (May 31).

Senior Lecturer in Mathematics—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 31).

Head of the Department of Chemistry and Dyeing, Bradford Technical College—The Director of Education, Town Hall, Bradford (May 31).

Science Lecturer to teach at least two of the following subjects: Biology, Chemistry, Physics, Mathematics, a Modern Language—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (May 31).

Readership in Medical Parasitology at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 2).

Graduate Teachers (2) to take courses up to Higher Certificate standard in (*a*) the Mechanical Engineering Department to teach subjects of Heat Engines, Strength of Materials, Theory of Machines, and Drawing and Design; and (*b*) the Electrical Engineering Department to take all subjects, including Mathematics—The Secretary, School of Engineering and Navigation, High Street, Poplar, London, E.14 (June 5).

Lecturer (Grade III) in Geography—The Registrar, Queen Mary College, Mile End Road, London, E.1 (June 7).

Lecturer to teach Physical Chemistry—The Registrar, University College, Hull (June 7).

Physicist to assist in research on application of physics in medicine, and a Junior Physicist to take part in clinical, teaching and research work—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3 (June 9).

Lecturer (Grade I) in Mechanical Engineering, and a Lecturer (Grade I) in Electrical Engineering—The Principal, Heriot-Watt College, Edinburgh (June 9).

Inspector of Explosives—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1878 (June 14).

Lecturer, and Demonstrators (2), in the Department of Chemical Pathology, and an Assistant Lecturer in Pharmacology—The Dean, Guy's Hospital Medical School, London, S.E.1 (June 14).

Assistant Lecturer in Chemistry, and a Lecturer (Grade II) in Botany—The Registrar, University College, Southampton (June 14).

Scientific Assistant—The Director, School of Agriculture, Cambridge (June 14).

Assistant (full-time), and an Assistant (part-time), in the Department of Psychology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (June 14).

Assistant Lecturer (man or woman) in Agricultural Chemistry—The Registrar, Wye College, Wye, Ashford, Kent (June 14).

Lecturers in Agriculture, Agricultural Chemistry, Agricultural Zoology, Mechanical Engineering, Civil Engineering, Botany, Chemistry, Pathology and Bacteriology, Anatomy, Physiology and Histology, Surgery and Medicine, for Gordon Memorial College, Khartoum, Sudan—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (June 15).

Chair of Physiology, a Lecturer in Special Sense Physiology, and a Lecturer in Histology—The Registrar, University College of South Wales, Cathays Park, Cardiff (June 15).

Assistant Lecturer (Grade III) in Mathematical Physics—The Secretary, The University, Edmund Street, Birmingham 3 (June 15).

Lecturer in Romano-British Archæology—The Registrar, The University, Leeds 2 (June 15).

Senior Physical Metallurgists (2), and Metallurgical Technicians (2), by the Department of Scientific and Industrial Research, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (June 15).

Lecturer in Chemistry—The Registrar, Trinity College, Dublin (June 15).

Lecturers (2) in Mathematics in the Natal University College—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (June 16).

Chair of Child Health—The Secretary, The University, Aberdeen (June 16).

Assistant Lecturers (2) in Botany (preferably with experience in Cell Physiology or Anatomy)—The Registrar, The University, Manchester (June 16).

Lecturer (Grade II) in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Liverpool (June 20).

Lecturer (Grade II) in Genetics—The Registrar, University College, Southampton (June 21).

Lecturer in Mathematics, or an Assistant to the Professor—The Registrar, Trinity College, Dublin (June 21).

Lecturer in Mechanical Engineering—The Registrar, Queen Mary College, Mile End Road, London, E.1 (June 23).

Chair of Geography at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 25).

Readership in Organic Chemistry at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (June 26).

Assistant Lecturer (Grade III) in the Department of Geography—The Secretary, University College, Gower Street, London, W.C.1 (June 30).

Assistant Lecturer (Grade III) in Geology—The Secretary, The University, Edmund Street, Birmingham 3 (June 30).

I.C.I. Research Fellowships in Physics and Chemistry, including Physical and Organic Chemistry, Biochemistry, Chemotherapy and Pharmacology—The Secretary, The University, Edinburgh (June 30).

Assistant in the Civil and Mechanical Engineering Department—The Secretary of the University Court, The University, Glasgow, W.2 (June 30).

Chair of Architecture—The Acting Registrar, The University, Sydney, Australia (July 31).

Senior Technician for Physics Department—The Secretary, Mount Vernon Hospital and the Radium Institute, Northwood, Middx.

Lecturer in the Department of Mathematics, and Lecturers in the Department of Applied Chemistry—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Technical Research Assistant by the Professor of Physiology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Assistant Lecturer in Physics—The Secretary, Royal Technical College, Glasgow.

Scientific Officer (Electrical Engineering and Instrumentation, temporary) at the Atomic Energy Research Establishment, Harwell, Didcot, Berks.—The Secretary, Ministry of Supply, Est.8C, Room 193, Shell Mex House, Strand, London, W.C.2.

Laboratory Assistant in the Department of Zoology—The Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey.

Chief Instrument Maker for Natural Philosophy Department—The Professor of Natural Philosophy, Royal Technical College, Glasgow.

Experimental Officer for testing dairy plant and equipment—The Secretary, National Institute for Research in Dairying, Shinfield, Reading.

Lecturer in the Engineering Department, and a Lecturer to teach Physics to the standard of Intermediate B.Sc. and some Mathematics—The Principal, County Technical College, Guildford, Surrey.

Assistant to teach Chemistry in the Technical Day School, and up to Intermediate B.Sc. degree standard in the Technical College—The Principal, Technical College, West Hartlepool.

Scientific Assistants (male or female) by the Ministry of Supply for chemical work, mainly of an analytical nature, at the Ministry of Supply Factory, Springfield, near Preston, in connexion with the Atomic Energy Production programme—The Appointments Officer, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1, quoting K.S.337.

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PAPER SHORTAGE, EDUCATION AND RESEARCH

THE debate on the book publishing trade in Great Britain which took place in the House of Commons on the adjournment on May 9 reflected general disquiet on the subject. The position had previously been the subject of letters to the Press by Sir Stanley Unwin and others, and of questions in the House of Commons itself, replies to which from the Government had not given satisfaction. The shortage of paper supplies existed before the fuel crisis, and the unsatisfactory position in regard to scientific and technical books was discussed in *Nature* of December 28. Sir Stanley Unwin in a letter to *The Times* stressed the way in which even Government departments as well as the schools and colleges have now become handicapped by the scarcity of books, and referred to the inability of publishers to meet the insistent demand abroad for British books, which can be looked upon as valuable contributions to the country's export target and also as a means for promoting knowledge of the British way of life.

These three points were brought together in the motion cited by Mr. Wyatt, which urged the Government to accept the principle that book publishing is an essential industry deserving a greater and more appropriate measure of priority in view of its importance to the culture of the country and to the export trade, and the necessity of maintaining and increasing the provision of text-books for schools and universities. Mr. Wyatt urged that the small amount of coal and paper consumed in book publishing is out of all proportion to the immense value to the community of books produced. Not more than about 2·5 per cent of the paper used in Britain goes to book publishers; Mr. Wyatt pointed out that 71,000 tons a year was consumed by the Stationery Office as against only 54,000 tons in 1946 by all the book publishers together. It is at present quite impossible to replace ordinary standard works to make good the ordinary wear and tear of libraries, quite apart from the replacement of copies destroyed during the War. All reserve stocks of paper for books, particularly school-books, have been used up, and with their present paper quota publishers cannot possibly begin to make up the present deficiency of books for schools or colleges, or of recognized classics, and at the same time continue publishing as a live industry.

The demand is, of course, greatly accentuated by the raising of the school-leaving age, the expansion of the universities and the increased demand of the public for reading matter which has grown up during the War. While every university or public library can bear witness to the intense and largely unsatisfied demand for text-books of all classes, including the set books for examinations, and to the number of students whose needs are not met, Mr. Wyatt pointed out that another serious feature of the situation is that the culture of the country is being stifled because publishers cannot publish the works of new authors. Mr. Wyatt, after referring also to the export trade and to the prestige value of British books abroad as more important than the financial aspect, emphasized particularly the way in which the sale of technical books abroad is being captured by the United States. The output of British scientific and technical books during recent years has been low enough, but Mr. Wyatt pointed out that because we cannot export our books, American publishers are buying the copyright to export them themselves, and their export trade in books has already risen from about £1,500,000 a year to three times that figure. Not only are books completely overlooked in the matter of priorities, but also the paper salvage drive is being neglected.

The debate itself illustrated the lack of appreciation of the position on the part of the Government, for the time allowed no other speeches than those of Mr. Wyatt and Mr. Belcher, Parliamentary Secretary to the Board of Trade, in reply. Mr. Belcher, who maintained that the Government does consider books an important part of the life of the country, urged that the position is not entirely due to lack of fuel: there is a twenty per cent. deficit of labour in the printing and bookbinding trades, and machinery has suffered from seven years depreciation and lack of replacement, apart from the destruction of about 5,000 printing machines during the War. Replacements will take from one and a half to two and a half years; the greatest problem, he said, is bookbinding machinery, which the Government is now arranging to import from the United States. Last winter, publishers were allocated 80 per cent of their pre-war consumption of paper, with an additional 10 per cent for export; and when, following the fuel crisis, it was agreed with the Publishers' Association to reduce the 80 to 70 per cent, the Government undertook to license in a subsequent period supplies to make up any deficiency on the 70 per cent in any one period. The coal allocation was increased from 33⅓ in March to 50 per cent in mid-April, and from June onwards the mills will receive an allocation of fuel equal to their full consumption in the summer of 1946. Paper supplies should therefore, according to Mr. Belcher, shortly reach the level anticipated before the fuel crisis, and the Government has made arrangements under which book publishers will receive a basic allocation of 60 per cent of pre-war consumption. In addition, they will be allowed 20 per cent, provided they devote the same proportion as before of their 60 per cent quota to educational or export books, and give an undertaking that they will use the additional 20 per cent for increased production of educational books for use in schools, colleges and universities and for home study, or for increasing their export targets. If, in the future, the amount of paper for book publishing were increased, the Government would hope to maintain these arrangements, with proportionate increases in the 60 per cent and 20 per cent figures. Mr. Belcher added that arrangements already made for publishers to receive from the special reserve of paper extra allocations for the production of essential books which they are unable to produce from their own quota would continue, and the Government has decided to divert from the reserve 1,000 tons for the production of educational text-books.

Much turns on the use of the term 'allocation'; in this connexion it means 'permission to buy' and is in no sense a guarantee that supplies will be obtainable. Further, the reference to the special reserve of paper, better known as the 'Moberley pool', is obscure; this reserve, of 1,500 tons, was established for the production of cultural and educational books, subject to detailed inquiries, and it is not apparent what change in policy is intended.

Moreover, there were several points raised by Mr. Wyatt and Sir Stanley Unwin to which no reply was made. The point about exporting paper, and particularly coated papers, was ignored; and Mr. Belcher in his reference to machinery did not indicate that the industry is to receive any priority in the replacement of worn-out machinery or in the allocation of raw materials. It is, in fact, the ignoring of this claim to priority and the absence of imagination in Mr. Belcher's reply which are the most disturbing features of a situation in which the virtual embargo on the output of new literature and of scientific and technical books is likely to persist.

Mr. Belcher may have dismissed the idea of salvage too lightly, and more might be done in the way of paper economy in the myriad fields in which paper is used in a modern community. It is, however, the manifold nature of those uses and the complex way in which they are entangled with almost every aspect of the life of the citizen—business, industrial and civic, as well as educational and cultural—that makes it so important that supplies should be brought to an adequate level as a priority of the first importance to every section of the community and every aspect of national life.

Here we cannot allow to pass unchallenged the question of the production of scientific and technical books. Apart from the fact that, as Mr. Wyatt pointed out, the sale of British technical books abroad tends to stimulate the sale of the British machinery and equipment described in such books and from the prestige element attached to sales abroad of such books, it is not altogether desirable that scientific men and technologists in Great Britain should be so largely dependent on books from other countries in their work. Scientific and technical advance in Britain might well be assisted if an attempt could be made to restore the balance which seven years of preoccupation with the demands of war has upset. British achievements and advances should be made known to the world at least in part by the men responsible, and also in books produced in Great Britain.

There is a further factor which was most evident at the time of the fuel crisis in the suspension of scientific and technical periodicals, but which, as was pointed out at the time, is an inevitable consequence of the shortage of newsprint. Scientific work and interests, as well as knowledge of public affairs, are liable to suffer from the compression and selection that are involved when newspapers and periodicals are severely limited in size. Scientific and technical factors themselves are often involved in the formation of sound public judgments on such matters as the fuel crisis, even though the problem appears as first sight to be purely political. Lord Marley, for example, pointed out in the House of Lords how neglect to apply available knowledge resulting from scientific research into fuel problems had contributed to the fuel shortage. His criticism was directed against sections of industry as well as against the Government itself; but if sound policy is to be evolved and appropriate administrative action taken, it is important that scientific and technical opinion should have the opportunity to express itself effectively before policy has been determined. The point is the more important because there are indications that measures of rationing contemplated are of the type that penalizes the efficient consumer, whether individual or industrial, and those who have responded most loyally to the appeal for economy.

The suspension of the scientific and technical Press of the country was a serious hindrance to the expression of informed, responsible and constructive criticism on certain highly important aspects of the situation, and in that alone was a threat to what is usually understood by 'the freedom of the Press'. Nor is that all. While in the technical field to which we have just referred, the ability of the engineer, the chemist, the physicist, the fuel technologist, and others to express sound judgments is unquestioned, there are also fields, such as that of management and administration, where the scientific worker and technologist have not only the duty to express an opinion when they can do so from personal knowledge and experience, but also where they may often be at least as competent to utter sound judgments as their fellow citizens. Only the most outrageous casuistry can pretend that behind the immediate physical difficulties which precipitated the fuel crisis and the long series of handicaps which the Government inherited from the past, there has not been the human contributory factor of procrastination and inept administration.

Scientific workers or technologists cannot be expected to make their due contribution to social and public affairs if arbitrary action such as occurred in the fuel crisis is allowed to obstruct informed comment and responsible criticism. It cannot be denied that the situation which involved the suspension of periodicals was preventable, and with reasonable foresight and competent administration would not have arisen. As the Commission on Freedom of the Press in America points out in a general report entitled "A Free and Responsible Press", if freedom of the Press is to achieve reality, Government must set limits upon its capacity to interfere with, regulate, control, or suppress the voices of the Press, or to manipulate the data on which public judgment is formed; and it goes on to point out that without intruding on press activities the Government can even help to improve the conditions under which such activities occur, and remove hindrances to the free flow of ideas instead of thwarting that flow, and promote, instead of check, the reality of public debate.

Freedom of the Press is indeed no less essential to scientific advance than to political liberty and to the creative activities on which the spiritual life of men depends. Where, as the Commission observes, men cannot freely convey their thoughts to one another, no freedom is secure. Moreover, science itself is a part of that civilized society which is a working system of ideas; and like it, lives and changes by the consumption of ideas, and can only indeed serve the society of which it forms a part by ensuring that as many as possible of the ideas of its members are available for examination by the scientific method, and that the results of scrutiny are fully and freely made known to society. That is the fundamental reason why the scientific worker as such is bound to protest against restrictive administrative action; this applies whether the action is due to lack of imagination as in the question of paper supply for books, or to the failure to observe in the fuel crisis the restraints which, as the American Commission insists, a democratic government is morally bound to respect in all circumstances.

PHILOSOPHY AND ITS BACKGROUND

History of Western Philosophy and its Connection with Political and Social Circumstances from the Earliest Times to the Present Day

By Bertrand Russell. Pp. 916. (London: George Allen and Unwin, Ltd., 1946.) 21*s.* net.

If one grants the assumption as to the nature of philosophy on which this book is based, it is a remarkable achievement. The assumption is, as Lord Russell says in the introduction, that philosophy is something intermediate between theology and science; it is a no-man's-land; it is speculation about the nature of the universe and the nature of things, based on the assumption that you can get definite answers on such subjects by speculation. Lord Russell does not think that you can do this, but the belief in the powers of such speculation has persisted and has produced many interesting results.

Western philosophy so conceived begins, not with Socrates but with Thales, and what this book does is to review the long history of men's speculations from Thales to the present day. The views of the philosophers are described with the beautiful lucidity of which Lord Russell is a master, and as he describes the views of one philosopher after another he adds witty, waspish, cynical and wise comments. If Edward Gibbon had been a philosopher instead of a historian, he might have produced a book very like this. It is a curious history because, according to Lord Russell, it has been all wrong. We have now, at long last, discovered that this speculation is vain. The answer to that effect has been finally and conclusively given by logical positivism. Yet I think that Lord Russell would still have us study philosophy, because he discerns as a by-product of this curious, mistaken activity a certain emotional temper, a certain contemplative attitude towards the world which he thinks is of great value.

Lord Russell makes a point of accompanying the accounts of the speculations of the philosophers with a statement of the historical background from which these speculations came. It appears to me that the idea is sound and valuable, but I cannot think much of the execution. I do not think that Lord Russell is a historian. The history is accompanied by interesting and illuminating comments, but some of it seems to me just the expression of Lord Russell's dislike, and not history at all. One has only to compare, for example, the chapter on "Die Anfänge des Judaismus" in Edward Meyer's "Geschichte des Altertums" with Lord Russell's chapter on the Jews to see what poor stuff the latter is. What is more curious is that Lord Russell does not really connect the history with the philosophy. His account of the philosophers is curiously unhistorical. He examines the work of one of them after another, selects the propositions which they believe to be true and which interest him, compares them with his own views, all as though they were contemporaries and not in the least as though their philosophy was integrated with, or really part and parcel of, the historical time in which they were living. It surprises me very much that anyone can discuss Socrates without describing the crisis through which Athens was passing in the fifth century as told, for example, by Thucydides. He writes of these various Greek philosophers of that time as though they were interesting and brilliant people who happened to turn up then, but who were not, as people, really concerned about the state of their civilization. All that Lord Russell does with the historical side is to show that this aloof, contemplative, speculative faculty as it appears in one man after another is to some extent influenced by historical events. I do not think he does anything like justice to the real interpenetration of philosophy and history. But that again is the result of his conception of what philosophy is.

One result of this conception of philosophy is that it confines philosophy to logic and metaphysics. There is nothing about the philosophy of history, and therefore not a word, in the modern section, about Vico or Croce or Dilthey. Similarly, there is nothing about æsthetics, and, most significant omission, philosophy does not include moral philosophy. Of course, Lord Russell has to make remarks about the moral views on philosophy held by Socrates, for example, or Locke; but he does not pay very much attention to them; they are not his concern. It is to me, therefore, no accident that Lord Russell seems to take a very unfavourable view of Socrates and Plato and, more especially, of Emanuel Kant, for their conception of philosophy was entirely different from his.

Perhaps the easiest way to put the point I want to make is to ask why earlier historians of philosophy have always held that Greek philosophy began with Socrates. They all, of course, recognized that the so-called pre-Socratics had something to do with philosophy; they held, nevertheless, that philosophy proper began with Socrates. The explanation is that Socrates was not just concerned with what Lord Russell regards as philosophical questions; he was concerned with the problem of standards in general. Socrates thought that Athens was going to pieces because the democracy of the day repudiated moral and political standards. He was sure that there were such standards, and he made it his business to examine and vindicate them. He did so very largely by directing attention to the existence of scientific standards in mathematics and by asking himself what was the relation between moral standards, or 'the just', and mathematical standards. Plato's theory of forms, which was an elaboration of Socrates, was not just a theory of universals; it was a theory of standards. Plato, for example, did not think there was a form of green; for we do not conceive of there being a green which is greener than any visible green. Socrates began by comparing the political teachers of the time unfavourably with craftsmen. The craftsmen at least knew the difference between good and bad work. The mathematicians knew the difference between mathematical thinking and vague guessing and purely empirical measuring. The recognition of the fact that there are good and just men as there are bad and unjust men is, to Socrates and Plato, and, for that matter, to Aristotle, a fundamental fact that has just got to be reckoned with. What philosophy does, as Plato explains in the Republic, is to reflect on the assumptions and hypotheses of the different inquiries and to consider their relation to one another. Such reflexion is clearly not in vain; it is very concrete and very definite. Of course, such reflexion on the nature of standards may, and in Plato does, result in conclusions which Lord Russell would call speculative. There is a very great division which runs through philosophy, conceived in the Platonic or Kantian sense, between those who hold that reflexion on assumptions and hypotheses leads to an apprehension of supersensible realities, and those who do not. Dialectic for Plato leads to such apprehensions; for Aristotle it is a form of false reasoning; for Hegel it is the highest form of knowledge; for Kant it is illusion. But that does not alter the fact that all these philosophers begin with the solid facts of human achievement, with the facts of right thinking and good conduct and fine art and just government.

This contrast I have been trying to make comes out more strikingly than ever if you compare Lord Russell's treatment of Leibniz with his treatment of Kant. Leibniz is, perhaps, his favourite philosopher and he puts him very high. Leibniz had an extraordinarily ingenious speculative mind, and, in my judgment, no sense of reality whatever. But he could perform to perfection the kind of ungrounded speculative thinking with which Lord Russell identifies philosophy. When Lord Russell comes to Kant he explains that he does not think much of him: of that one cannot complain; but the extraordinary thing is that he considers Kant's most important contribution to be his view of space, a view taken by Kant in his pre-critical period; and what Kant regards as his far-reaching discovery, that metaphysics should be criticism, is not expounded or examined. Kant is not a speculative philosopher; he does not believe in speculative philosophy. He started with his feet most firmly on the ground, with being quite certain that there was all the difference in the world between science properly so-called and what he describes as "groping around"; between doing what you ought and doing what you happen to like; between great art and finding what would tickle the public; and he sets himself to ask how these great achievements of the human spirit were possible, how alike or how different they were in methods and assumptions and what they implied.

Those seem to me to be the two main ways of regarding philosophy. I entirely accept the Kantian revolution, and therefore I cannot be expected to have much sympathy with Lord Russell's pre-revolutionary conception. But, as I said at the beginning of this review, if you do accept Lord Russell's assumption as to what philosophy is, this is a very remarkable performance. For those who like this sort of thing, this is indeed the sort of thing they like.

LINDSAY OF BIRKER

CAUSAL FACTORS IN SCHIZOPHRENIA

The Biology of Schizophrenia

By Dr. R. G. Hoskins. Pp. 192. (New York: W. W. Norton and Co., Inc.; London: Chapman and Hall, Ltd., 1946.) 15*s*. net.

THE greatest problem of modern psychiatry is that of schizophrenia. The vast majority of the permanent occupants of the mental hospital consists of patients suffering from this disease, which besides cripples a large number of patients who contrive to live a precarious existence in the outside world as tramps, eccentrics, prostitutes and similar misfits.

Dr. Hoskins' book is a valuable review of this psychosis. It is an expanded version of his three Salmon Lectures. The first part is devoted to a description of the development of human personality and social community on the basis of emergent evolution. The second part is a description of schizophrenia as a pattern and the comparison of it with various biological reactions found in other animals. It is the third part which will be of most interest to the clinical psychiatrist and the research worker. In this part he reviews a large amount of modern literature and examines the various possible causes for the curious symptoms which characterize this disease. He examines the endocrine factors, the oxygen relationships, the carbohydrate metabolism, the circulatory conditions and the importance of hæmostasis. Many of the facts which Dr. Hoskins discusses here have been determined by his own research team at Worcester State Hospital.

It is obvious that in research upon an obscure disease process such as schizophrenia there is no one method of approach; but it is rather the correlation of the multitudinous minor discoveries which will give the final clue. Dr. Hoskins wisely takes the biological stand and attempts to fit together what is known; but unfortunately not enough has yet been discovered to make it possible to solve the problem. He seems to think that the avenues of research tend to lead towards the problem of maturation as related to the endocrines, vitamins and enzymes. He points out that the schizophrenic is lacking in empathy (the basis of emotional relations with others), and that if we could discover the cause of this deficiency we should be advancing our chances of solving the whole problem. In this matter he points out that feral children—children who have been adopted by wild animals since an early age—are totally lacking in power to show empathy. He suggests the importance of inheritance by quoting the well-known work on twins, in which it was shown that if one of monozygotic twins developed schizophrenia this also tended to appear in the other, while dizygotic twins did not show similar reactions.

Dr. Hoskins shows an easy tolerance to all schools of psychiatry and writes fairly and generously from all points of view. His style is clear and understandable—a virtue not always found in psychological books. The format itself is excellent, the print is clear, with wide margins such as have not been seen in Britain since the paper shortage. The binding is good. There is a long list of references, which are valuable to those who wish to read one particular part of the literature, and there is an excellent index.

Clifford Allen

A BIRD PHOTOGRAPHER ABROAD

Bird Life in Two Deltas

Being the Diaries of a Bird Photographer in the Estuaries of the Guadalquiver and the Rhone and their Neighbourhoods. By G. K. Yeates. Pp. 159 + 68 plates. (London: Faber and Faber, Ltd., 1946.) 15*s*. net.

THE standard of bird photography has risen high in recent years, but we have no better exponent of the art, for an art it has become, than G. K. Yeates. His bird portraits are superb examples of the work of the camera. In his latest book, "Bird Life in Two Deltas", we see pictures taken in Spain and in the south of France. "The Spanish *marismas* at the estuary of the great Guadalquiver and the Camargue or Rhône-Delta constitute two of the greatest bird paradises in Western Europe", says the author. He goes on, "The brief visits of a foreigner to these great oases of bird-life, so vast that even a lifetime would leave much unseen and unexplored, can in themselves provide only a fleeting glimpse into the wealth and variety of their natural history. These three diaries which follow are the unadorned records of my visits."

But the diaries, if 'unadorned', are not the less interesting for that, for they tell a plain story very well, the story of a naturalist in a rich field, of his difficulties, his triumphs and his many observations. Here is his account of flamingoes: "Never have I been so moved by the sheer wondrous beauty of a bird as I was today by these flamingoes. . . . We first saw the birds as a long thin pink line through the mirage. As we came closer, they assumed more definite shape. When wading through the shallows, the flamingoes' general colour scheme is a very soft pink. The body appears like a round ball precariously balanced on two long pink stilts. The long thin serpentine neck with the curious heavy downward-tilted bill completes a strange picture. . . . The soft reflections of the long thin pale-pink line in water that took its colour from the blue of the sky defeat my poor pen for description."

Yeates adds: "Lovely as is the flamingo as it wades, it is a flash of glory on the wing, for then instead of the soft pinks which predominate on the ground the bird exposes the brilliant scarlet of the covert feathers . . . nor is it just one bird in the air. Numbers on such a scale are difficult to estimate, but I do not think 1,500 far short of the birds that were here present."

Buff-backed herons, little egrets, black-winged stilts, night herons, hoopoes, etc., provide the author with many observations on bird behaviour and with photographs of remarkable quality.

Of special interest are his records of the penduline tit in the act of constructing its nest. Photographs of nest-building are rare. This species contrives a lovely little domed nest after the style of that of the familiar long-tailed tit, but uses reed 'down' instead of moss and lichen. A favourite site is among the drooping sprays of tamarisk. We here see stages in the building, an outer circle or hoop being first constructed, in which the bird works and builds up the main walls.

Several useful appendixes are to be found at the end of the book—a bibliography which will be helpful to anyone desiring to look up the literature of these bird paradises, a list of scientific names and a list of the French names of the Camargue birds.

Frances Pitt

BRITISH SCIENTIFIC INSTRUMENTS

PHYSICAL SOCIETY'S EXHIBITION

THE healthy condition of the British scientific instrument industry was again demonstrated at the second post-war exhibition held by the Physical Society at the Imperial College of Science and Technology, South Kensington, at Easter. In the past it has been customary to hold the exhibition early in January, but owing to the extraordinary and unforeseen large increase in attendance at the first post-war exhibition (held January 1946), it became necessary to make fresh arrangements. These took the form of a restriction in the number of tickets issued (limited to about 12,000), an increase of the floor space of the exhibition (extending into a part of the Science Museum), and an increase in the period during which the Exhibition was open, from three to four days (April 9–12 inclusive). It was mainly due to this latter change that the Exhibition, the thirty-first of the series, was held at Easter instead of the New Year. These changes certainly had the desired effect, and visitors this year were able to view the splendid display of scientific instruments under relatively comfortable conditions.

Owing to paper supply and printing difficulties arising from the fuel crisis, it was not possible to produce the catalogue in time for the Exhibition. Consequently, a concise 8-page guide was issued for the convenience of visitors to the Exhibition, followed afterwards by the catalogue itself, a well-illustrated volume of about 380 pages. This catalogue is much more than a guide to the Exhibition: it is, in fact, a work of reference containing descriptions of a very large number of scientific instruments manufactured in Great Britain during recent years.

The Exhibition was a tribute to the high degree of skill and ingenuity shown in the design and manufacture of high-class scientific instruments in Britain. As in previous years, it was divided into two main sections, namely, the Trade Section and the Research and Educational Section. The Trade Section included exhibits from 118 firms of instrument makers, while the Research and Educational Section was represented by twenty-nine organisations, many of these being Government research establishments. During the Exhibition, four discourses were given on recent advances in various aspects of the development of scientific instruments. One of these, given by Dr. Edward Lee (of Admiralty Research Laboratory, Teddington), dealt with the development of certain types of Service infra-red equipment which has in post-war years found valuable applications in research and industry. He dealt in particular with the image-converter tube in which infra-red radiation up to a wave-length of 1·3 μ is transformed into visible radiation. During the discourse the audience were supplied with the Service type of this tube (the R.G. tube) enabling them to see demonstrations of various interesting infra-red phenomena. Dr. Lee referred also to recent progress in the production of lead sulphide photo-conducting cells sensitive up to a wave-length of 3·5 μ. These cells have been used recently in observing transient low-temperature effects which were previously undetectable. He referred to the use of infra-red equipment fitted to military vehicles for driving at night and to the detection of the exhausts of enemy aircraft.

Interesting and instructive discourses were also given on "Recent Advances to Optical Science" and on "Air Photography" by Mr. B. K. Johnson (Imperial College) and by Mr. A. C. Brock (Royal Aircraft Establishment, South Farnborough) respectively. Prof. A. Porter in his discourse dealt with the important subject of "Automatic and Manual Position Control Systems". His remarks were based on various mechanical aspects of fire control and radar systems as used in the Services. He was mainly concerned with a discussion of the relative effects of inertia and damping in follow-up mechanisms, and the introduction of controls including the first and second differentials of displacement.

These discourses are not only of interest to the specialists but have also a more general appeal, and are now one of the important features of the Exhibition. Another feature which is gradually assuming greater importance is the exhibition of scientific and educational films. One of these, of more popular interest, was a 50-min. film depicting episodes in the life of Lord Kelvin. The British Kinematograph Society showed ten films illustrating the uses of motion pictures in scientific research; for example: (1) kine radiograph of normal human joints; (2) super-slow motion of a splash; (3) films in aircraft research, etc. Another film, shown by Kodak, Ltd., Research Laboratories, illustrated the use of the phase-contrast microscope in biological studies.

In a brief review of the Exhibition, it is almost impossible to select even a representative sample of the very numerous exhibits for reference. The following, taken almost at random, may, however, serve as a rough indication of the type of exhibits to be seen. Microscopes, for example, in recent years seem to be departing more widely from the old conventional forms. In the Research Section was shown a reflecting microscope having a numerical aperture of 0·98, with exact focal achromatism, fitted with phase-contrast illumination. Using this instrument, photomicrographs of stained and unstained material (by phase contrast) were shown. Another microscope, of an entirely different type, is the electron microscope. This has now been used in a 'shadow casting' method. Shadow-casts are formed by irradiating a supported specimen obliquely, *in vacuo*, with a stream of gold molecules. Such objects when viewed by transmission in an electron microscope show shadows and gradations of density in a pattern which indicates the detailed shape of the original specimen. A 50 kV. electron microscope, giving total magnifications of the order of 20,000 times, was on view in the Trade Section of the Exhibition. The resolving power of the instrument was stated to be better than 100 A.

Reference has been made to infra-red sensitive cells in Dr. Lee's discourse. The characteristics of lead-sulphide cells as applied to high-speed low-temperature pyrometry were shown in the Research Section. One exhibit demonstrated the quick response-time of the lead sulphide cell, about 20 microsec. at room temperature. At the peak of its sensitivity curve (2·7 μ), it is almost a hundred times as sensitive as the best thermocouple. At liquid-air temperatures its sensitivity is greatly increased, but its response time is now of the order 500 microsec. In addition to its use in spectroscopy, the lead sulphide cell is finding many applications in industrial processes and in research.

Developments in electrical (and electronic) instruments are particularly noteworthy, and more 'Service' applications were released in time for this Exhibition. One form of bomb locator which was exhibited was in principle a very sensitive magnetometer for measuring the distortion of the earth's magnetic field due to the presence of ferro-magnetic material. The sensitive element in this locator is a length of mu-metal wire, the A.C. resistance of which varies with the field along the axis of the wire. Variation of the resistance is indicated by a sensitive bridge circuit. Two widely spaced elements are used to indicate the field gradient.

Perhaps one of the most popular and striking exhibits was the demonstration of centimetre waves and the equipment used in the generation, transmission and reception of centimetre waves. Wave guides, magnetrons, klystrons, dielectric rod and tube aerials, lens-corrected horns, crystal receivers, concentric probes, bolometers for power measurement, polarization-plane changers, etc., for use in micro-wave communications and research were to be seen on several stands both in the Trade and Research Sections. Demonstrations were given illustrating the properties of centimetre waves such as reflexion, focusing, stationary waves, polarization and attenuation.

In the Trade Section a cathode ray tube known as the 'Skiatron' was demonstrated. In this tube the electrons, instead of causing fluorescence when they strike the screen, produce an image of varying opacity which can be projected on a screen, using conventional sources of high-intensity illumination, instead of relying on the relatively weak illumination produced on a fluorescent screen.

Another interesting exhibit in the Trade Section was the equipment used in picture telegraphy. This equipment was designed primarily for use by the Press for the transmission of news-pictures directly over existing telephone networks, or in conjunction with radio links. The commercial applications are obvious, and the system offers possibilities in crime detection, since it permits of rapid transmission of finger-prints and other pictorial matter. The definition obtained in this system is very good, and the speed of scanning satisfactory; for example, a picture 10 in. × 8 in. can be transmitted in 7–20 min., according to the scanning-line and drum speed combination.

An entirely novel feature in this year's Exhibition was the exhibit of the Atomic Energy Research Establishment (Electronics Group). Electronic β-ray counters and health monitors for β- and γ- and slow neutron radiations were demonstrated. Much interest is being taken in the design of Geiger counters and in various forms of apparatus for measuring ionization, with associated electronic equipment. Counting rates as high as 5,000 a minute are now readily obtainable—this compares very favourably with the normal rates of 20–30 a minute when counting α-particle scintil- ations by eye. The importance of the exhibit was not so much in what it actually showed as in what it foreshadowed.

In acoustics, improved types of noise meters were exhibited, and a demonstration was given of the absolute pressure calibration of a microphone by measurement of the amplitude of smoke particles. A novel application of soap films was demonstrated in gas analysis apparatus embodying a dynamic method instead of the more usual static method. The apparatus consists of eight soap film meters incorporating the necessary absorbent solutions. To arry out an analysis, which can be completed in hree minutes, soap films are formed in each meter by raising and lowering valves.

The use of silicone-insulated windings in electric motors running at abnormally high temperatures was demonstrated in another research exhibit.

It is hoped that the above examples sufficiently illustrate the wide range covered by the exhibits. It is practically impossible for the normal visitor, who has only one day to spare to visit the Exhibition, to see everything. All he can do is to take a particular interest in a few items and a more general interest in some of the others—if time permits between his chance meetings with old acquaintances!

The thirty-first Exhibition was, if possible, even better than its predecessors, and the exhibition committee and officers of the Physical Society are again to be congratulated most heartily in the well-merited success of their annual effort.

ACTION OF MUSTARD GAS (ββ'-DICHLORODIETHYLSULPHIDE) ON NUCLEOPROTEINS

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AND
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EARLY studies on the reactivity of mustard gas (ββ'-dichlorodiethylsulphide) with amines and amino-acids[1,2,3] provided the first indication that its vesicant action might depend on a combination with protein constituents of the living cell. Additional indirect support for such a view was the observation that respiratory and glycolytic processes of bacteria[4] and of minced tumour tissue[5] were inhibited by mustard gas *in vitro*, and that with the sulphone analogue there was inhibition of metabolism of brain tissue *in vitro*, representing a selective effect on the pyruvate oxidase system[6]. Actual evidence that mustard gas could combine with proteins became available when serum proteins were shown to acquire new antigenic properties after treatment in the cold with mustard gas[7].

The antigenic change in serum proteins seemed too feeble, however, to account for the striking biological effects of mustard gas *in vivo*. It seemed desirable, therefore, to repeat the work, using skin proteins instead of serum proteins as test material. Preliminary experiments of this kind yielded, however, unexpected results.

A crude aqueous extract of rabbit skin, when shaken with mustard gas, developed a bulky protein precipitate, having a high sulphur content (thus indicating a combination of the protein with the mustard gas), and a high phosphorus content (suggesting that it was nucleoprotein in type). When a more purified preparation of nucleoprotein, derived from calf thymus, gave similar precipitation with mustard gas, while a number of other proteins failed to give this reaction, the originally planned (immunological) work was set aside, and the precipitation phenomenon investigated in greater detail.

Preparation of extracts: Finely minced tissue (skin or thymus) was extracted first with distilled water, and then with several lots of dilute borate buffer at *p*H 8·5. After removal of insoluble matter by centrifuging, the pooled solutions were brought to *p*H 6·0 with dilute acetic acid, and the resulting precipitate separated by centrifuging, and dissolved in 0·05 N ammonia. This was filtered repeatedly through the same filter paper until clear. (This filtration, which lasted several days, was carried out at 3° C.) The clear filtrate was desiccated by lyophilic drying, and the powder extracted in a Soxhlet apparatus with light petroleum (b.p. below 40° C.). Other methods of extraction yielded preparations which reacted essentially in the same way when treated with mustard gas, and need not, therefore, be described here in detail.

The powder was readily soluble in alkaline solutions at and above *p*H 7·5. On acidification to below *p*H 6·5, a precipitate was formed, which dissolved again on re-addition of alkali. An analysis of the powder gave the following values: 12·2 per cent N; 0·89 per cent P; and 1·1 per cent S. (The nitrogen content of nucleoproteins is usually given as about 16 per cent. The somewhat lower value given above is attributable to a relatively high ash content of the test sample.)

Treatment with mustard gas: In the standard test, 0·5–1·0 per cent of nucleoprotein preparation in $M/20$–$M/4$ borate buffer at *p*H 9·0 was continuously shaken with 1 per cent mustard gas per volume of solution, at 37° C. The *p*H of the mixture was adjusted every few minutes, with small additions of dilute sodium hydroxide (using an external indicator), to neutralize the hydrochloric acid liberated from hydrolysis of mustard gas.

Precipitation occurred whether crude or purified preparations were used, or whether these were derived from rabbit skin or calf thymus. (For negative results in concentrated phosphate buffer, see below.) The precipitation began within 2–5 minutes, becoming first noticeable as a turbidity which failed to clear on further addition of alkali.

Influence of *p*H*:* Maximum precipitation occurred in borate buffer at *p*H 8·5–9·0, falling off considerably at *p*H 9·5, and no longer occurring at *p*H 10·0. In phosphate buffer between *p*H 8·0 and 9·0, only slight precipitation occurred. In acetate buffer, from *p*H 6·5 downwards, the normal precipitation (due to acid *p*H itself) became converted into an irreversible precipitation, after shaking with mustard gas (that is, the precipitate failed to re-dissolve on addition of alkali).

The poor precipitation in phosphate buffer was traced to the relatively high competition factor[8] of phosphate ions for mustard gas in the reaction mixture. (This possible mechanism was suggested to us by Mr. J. St. L. Philpot.) Thus, more precipitate developed with mustard gas in a mixture of borate and acetate buffer at *p*H 8·2 than in phosphate buffer at the same hydrogen ion concentration, while no precipitate developed when the concentration of the phosphate buffer was raised to three molar.

Variation in the concentration of reagents: By varying the concentration of nucleoprotein in the test mixture, corresponding differences were obtained in the yield of precipitate, from a bulky precipitate with 1·5 per cent to a mere trace of turbidity with 0·001 per cent. Diminution in precipitation with decreasing amounts of mustard gas (acting on 1 per cent nucleoprotein) followed a more rapid course, from bulky precipitate with 1 per cent mustard gas to turbidity with 0·05 per cent. This was accounted for by the large proportion of mustard gas becoming hydrolysed before being able to act on the nucleoprotein.

Acid effect in mustard gas precipitation: Though the precipitate produced by acid is reversible (that is, it redissolves on addition of alkali) whereas that produced by mustard gas is irreversible, it seemed possible that during the hydrolysis of mustard gas, the acid *produced at the actual point of liberation* might be sufficiently concentrated to cause denaturing of the nucleoprotein. This was excluded by the following tests:

1. Mustard gas and nucleoprotein tested in strongly buffered solution, with frequent adjustments of *p*H and vigorous shaking, so that the maximum fall in *p*H was never more than 0·5: precipitation occurred as usual.

2. Small amounts of concentrated hydrochloric acid, instead of mustard gas, added to a buffered nucleoprotein solution: no irreversible precipitation.

3. Other compounds, known to liberate hydrochloric acid through hydrolysis (see below), tested on nucleoprotein solutions: of these, lewisite, dichlorodimethylsulphide, and *t*-butyl chloride, failed to produce irreversible precipitation.

4. Estimation of sulphur content of nucleoprotein before and after treatment with mustard gas (uncombined mustard gas being removed by extraction of the precipitate with lipoid solvents): sulphur content of acid-precipitated nucleoprotein ranged from 1·1 to 1·7 per cent; sulphur content of treated nucleoprotein with mustard gas ranged from 1·8 to 3·3 per cent, the higher figures being obtained in tests with prolonged treatment with large excess of mustard gas.

Effect of mustard gas on other proteins: Similar tests to the above were made on serum globulin, serum albumin, fibrinogen, prothrombin, hæmoglobin, gelatine, pepsin, and ribonuclease. In the standard tests (lasting 20 minutes) no precipitates developed (except with hæmoglobin, which was accounted for by non-specific precipitation resulting from prolonged shaking).

The tests were repeated for longer periods, with the mustard gas added in divided doses (1 drop to 30 ml. of test mixture every 15–20 minutes) and the amounts of precipitate estimated nephelometrically in a 'Spekker' photo-electric absorptiometer: no effect was observed with ribonuclease; slight turbidity only with pepsin, gelatine, albumin, prothrombin and fibrinogen (the last-mentioned being non-specific, due to shaking); progressively increasing precipitation with globulin, though very much more slowly than with nucleoprotein.

Nucleoprotein precipitation in vivo: If the nucleoprotein inside the living cell became irreversibly denatured following mustard gas application, the amount of soluble nucleoprotein extractable from such tissue should be greatly reduced. This was investigated.

Some neat mustard gas was applied to a large area of skin on rabbits, and two hours later (by which time erythema and œdema were well pronounced), the treated skin, as well as neighbouring normal skin for control, were excised and extracted by the method described above: no detectable nucleoprotein was obtained from the treated skin, whereas the normal skin yielded abundant quantities. When tested at shorter intervals (½–1 hour) after application, some nucleoprotein was extractable from the treated skin—though in greatly diminished amounts compared with the normal skin.

At the suggestion of Dr. R. H. S. Thompson, these tests were repeated on rat skin, using much smaller quantities of mustard gas (for example, 1 drop of a 5 per cent solution in ethanol, an amount known to be just sufficient to produce œdema, and to interfere with enzymic activity of the skin): under these conditions, apparently normal yields of nucleoprotein were obtained from the treated skin (any precipitation that may have occurred being too small to be detected by the semi-quantitative method of comparison used).

Effect of other compounds on nucleoprotein : This investigation, forming part of a separate study, gave results of interest in connexion with the present work, and may be summarized as follows : similar precipitation of nucleoprotein was obtained with a few compounds closely related chemically to mustard gas, all possessing strong vesicant action. On the other hand, lewisite gave no precipitation. In the case of ββ'-dichlorodiethylsulphone and of divinylsulphone, no actual precipitation occurred, but the precipitate formed on acidification (subsequent to the treatment with these compounds) failed to re-dissolve on addition of alkali. (These last results need confirmation on other samples of nucleoprotein.)

Dichlorodimethylsulphide (an analogue of mustard gas, almost non-vesicant, but hydrolysing rapidly in water), also *t*-butyl chloride, and other related compounds, produced no precipitate when shaken with nucleoproteins.

Though conclusions from *in vitro* tests with purified proteins must be accepted with caution, since the 'purification' may have contributed towards the effects produced, the observation that nucleoproteins are rapidly precipitated by mustard gas is rendered significant by the fact that after treatment of skin with mustard gas *in vivo*, no soluble nucleoprotein is any longer extractable. The formation of an insoluble nucleoprotein-mustard gas compound cannot, therefore, be attributed to the use of partially denatured nucleoprotein, but represents a product of interaction which bears some relation to the action of mustard gas on living cells.

As evidence that mustard gas can combine with proteins, these findings support the previous results from immunological studies[7], and are in keeping with he more recent results with corneal collagen[9], keratein[10], various proteins, using mustard gas with adioactive sulphur as tracer[11], egg albumin, casein, and amino-acids[12]. (Reference should also be made o the observed interaction between 'nitrogen mustards' and sodium thymonucleate, etc.[13])

However, unlike the compounds formed by mustard gas with other proteins, that formed with nucleoprotein is highly insoluble. Such specific precipitation *n vivo* may produce special effects, for in failing to precipitate cytoplasmic proteins, mustard gas might be able to penetrate the nucleus and produce characteristic changes there. In this connexion, it may be noted (*a*) that the lethal effect of mustard gas on cells delayed for several hours, as with X-rays, but nlike most other irritants, and (*b*) that mustard gas lso behaves like X-rays in producing mutations in *Drosophila melanogaster*, while other irritants (includng lewisite) do not[14].

Intra-nuclear precipitation of nucleoproteins could nly represent one aspect of the biological action of mustard gas. Apart from the cytoplasmic nucleoroteins, associated with mitochondria, microsomes, tc., there are enzymes of nucleoprotein type (for example, the flavoproteins) in the cytoplasm, precipitation of which would seriously interfere with function. Furthermore, combination of proteins (or other important cell constituents) with mustard gas, *without precipitation*, would also lead to important changes in living cells.

Recent evidence points to a multiple mechanism of vesicant action, and the present results lend further support to this view. Some of the local effects are more likely to be associated with interference with enzyme action in the cell[15], while the hypersensitivity which may develop after repeated exposure is more readily explained on the development of antigenically changed proteins[7]. Nevertheless, in view of the important role which nucleoproteins have in the living cell, their irreversible precipitation *in vivo* is likely to have serious consequences, and may well be largely responsible for the necrotizing effects in mustard gas burns.

This work was carried out in 1940 as part of a programme of extramural research for the Ministry of Supply, and communicated to the Ministry in 1940. We wish to thank Prof. R. A. Peters and other members of the group working in this field in Oxford, for helpful advice, and the Director of Scientific Research (Defence), the Ministry of Supply, for permission to publish these results.

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STRUCTURE AND PROPERTIES OF DIAMOND

THE diamond offers a variety of fascinating problems to the research worker interested in the correlation of physical properties with crystal structure, and the well-known variations of crystalline habit, colour, fluorescence, and so forth, are responsible for a bulky scientific literature. Its scientific interest and its beauty as a gem inspired many abortive attempts at synthesis, and probably one successful solution of the problem[1]. It is not surprising that the diamond was among the very first crystals examined by X-ray methods, and the essential simplicity of the structure is in striking contrast with the complexity revealed by a detailed examination of the crystalline form and properties.

The researches of Robertson, Fox, and Martin, published in 1934[2], established firmly the existence of two kinds of diamond, known as Type I and Type II for lack of clear understanding of the origin of the observed differences in various physical properties. Since that time, much experimental data has been obtained by X-ray methods in the Davy

Faraday Laboratory, London, and it is now at least possible to show in what respects the X-ray diffraction effects characteristic of diamonds of Types I and II are *not* explicable in terms of theories which cover phenomena observed with other crystals. A very large amount of interesting experimental work has also been reported in publications from the Indian Institute of Science at Bangalore, especially in two symposia[3,4] on the "Structure and Properties of Diamond". The team at Bangalore, under the direction of Sir C. V. Raman, originally directed attention to anomalies in X-ray scattering, and has more recently applied a variety of physical methods to the examination of a very fine collection of diamonds. The earlier work (particularly that on diffuse X-ray reflexions) served as the basis for the development, by Raman[5], of a general theory of the dynamics of the crystal lattice which has been strongly criticized by theoretical and experimental workers[6] and has not found acceptance in other laboratories than that at Bangalore. Later, in order to provide a structural interpretation of experimentally observed variations in physical properties and growth habit, Raman[3] advanced a theory of the symmetry of diamond which implies the existence of four different crystal structures. Raman's exposition and development of this theory were much less obscure than in the case of the general theory of the crystal lattice, but its application to X-ray diffraction effects has been criticized very severely[7], and again it must be admitted that acceptance is withheld, outside the Bangalore laboratory.

It is against this background that the second symposium on the structure and properties of diamond[4], here under review, must be judged. The style and general content of the twenty-one papers, all contributed by Raman and his collaborators in the Bangalore Institute, show no serious departure from those of previous publications from this school of research; the treatment is in many cases descriptive rather than analytic, and, in the reviewer's opinion, the value of the observational data is reduced rather than enhanced by the insistence with which they are adduced in support of the Raman theories, and stated to be in flat opposition to others. This treatment succeeds only in conveying the impression, whether rightly or wrongly, that the Raman theories dominate the experimental researches of the Bangalore school to an extent which must encourage an uncritical acceptance of interpretations favouring Raman's views, while adverse criticisms of the Raman theories, expressed by other workers in this field of research, remain unrefuted. In the review which follows, therefore, no attempt is made to assess the theoretical significance of the new experimental data.

Crystalline Form and Microscopic Structure

In the first of four papers on topics which may be grouped under this heading, Raman and Ramaseshan (pp. 1–24) develop the idea that the curved faces and edges which frequently occur in natural diamonds are not accidental features of growth, as is commonly supposed, but represent essential properties of the crystal. On this view the curved faces appear as a direct consequence of the act of solidification from a drop of liquid carbon, while the edge-development gives the clue to the true internal symmetry of the structure; the majority of the seventy-two diamonds examined are classified, in this way, as showing tetrahedral symmetry, though truly octahedral symmetry is established in some cases and interpenetration of positive and negative tetrahedral forms is frequent. A semi-quantitative elaboration, by Ramaseshan (pp. 122–129), of the suggestion that curvature of the faces corresponds directly with curvature of the liquid drop of carbon, requires the *ad hoc* assumption that a high degree of directed valency-bonding exists before solidification. The calculations of crystal surface energies are correlated with cleavages in another paper by Ramaseshan (pp. 114–121); but it is perhaps not unreasonable to suggest that these calculations, and the deductions drawn from them, may represent an over-simplification of the very complex energy problems associated with crystal growth and face-development under conditions and in an environment of which little or nothing is known. For their bearing on these views as to the significance of curved faces and edges, the recent experimental observations of Tolansky and Wilcock[8] are of great interest; it seems that the multiple-beam interference technique establishes beyond any reasonable doubt that these features of the topography of the diamond are due to the deposition of a succession of stepped growth-sheets—a mode of crystal growth commonly observed in other substances.

A paper by Ramachandran (pp. 65–80) describes in detail the dimensions, orientation, and optical characteristics of the laminated structures seen under optimum conditions in many diamonds of Types I and II, and attributes the positive and negative uniaxial characters of the laminæ to states of compression and tension arising from variations in lattice-spacing in the different kinds of diamond structure postulated by the Raman theory. The rea existence of such variations in spacing, reported by R. S. Krishnan[3], has, however, been denied by Lonsdale[7], so that the validity of Ramachandran's interpretation of his observations is open to question.

X-Ray Studies

Studies by R. S. Krishnan (pp. 33–44) and by Ramachandran (pp. 95–103) represent the extensio and refinement of researches already reported, th former on the temperature-variation of lattice parameter, the latter on X-ray topography, with a attempt to correlate variations in X-ray reflectin power with the laminations observed optically an with luminescence phenomena.

In a theoretical study, Ramachandran (pp. 58–64 calculates the X-ray diffraction effects to be expecte for a diamond structure in which carbon atom occupy the sites 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ in the cubic unit cell, bu are assumed to have non-spherically symmetrica electronic configurations. He concludes that it i impossible from the presence or absence of the (20 and (222) reflexions to decide uniquely whether th symmetry of the crystal is tetrahedral or octahedra He states, however, that "the (222) reflection is . . absent only in the fully antisymmetric case", whic (if the reviewer has understood Ramachandran nomenclature correctly) is equivalent to saying tha the (222) reflexion is absent only when the two carbo atoms at 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ are identical and have identic orientations, a requirement of the tetrahedr structure. Lonsdale[7] has shown that a real (22 reflexion exists, which would appear, on Ramacha dran's own calculations, to prove that the symmet is octahedral.

Atomic and Electronic Vibrations

The greater part of the symposium is devoted to the observation of optical properties and their interpretation in terms of atomic and electronic vibrations.

Precision measurements are included in six papers, of which two by Krishnan (R. S.) (pp. 25–32 and 45–57) report observations of the second-order Raman spectrum and its variation over a wide range of temperature. Ten distinct second-order lines have frequencies corresponding with infra-red absorption maxima, and five of them are octaves of the frequencies assigned in the Raman theory to lattice vibrations. It is difficult to attach any real significance to the proposed interpretation of the Raman spectra, when Krishnan persists in associating the octave of the fundamental Raman frequency 1332 cm.$^{-1}$ with the steepest point in the curved line joining an infra-red absorption maximum with the adjacent minimum —an arbitrary proceeding already condemned by Sutherland[9]. On the purely experimental side, however, it is to be noted that a recent communication in *Nature*[10] by Krishnan reports the complete resolution of the Raman lines, which in the symposium appear only as minute 'steps' on a continuous faint background.

Four papers by Ramanathan (pp. 130–161) describe infra-red, visible, and ultra-violet absorption properties of a large number of diamonds, and demonstrate that it is not possible to draw a definite line of demarcation between Type I and Type II diamonds from observations on infra-red absorption near 8 μ and ultra-violet absorption near 2250 A.

Descriptive accounts of the luminescence exhibited by diamonds under various stimuli occupy no fewer than five papers, and Ramachandran (pp. 81–94) outlines a semi-quantitative theory of the luminescence due to X-ray excitation. In a short review it is possible to do no more than indicate some of the effects described and discussed in papers by Rendall (pp. 168–175), Chandrasekharan (pp. 182–197), Ramachandran and Chandrasekharan (pp. 176–181); they include the blue and yellow fluorescence patterns, phosphorescence which persists for a short time after cutting off the exciting radiation, thermoluminescence observed on heating to 270° C., and the deactivation effect of radiation of wave-length longer than 4200 A., which causes a 'flash' emission of visible light. In the last of the papers listed above, Ramachandran and Chandrasekharan bring some evidence in support of their suggestion that luminescence effects are due to 'forbidden' electronic transitions.

Conclusion

The symposium includes also papers by Ramaseshan (pp. 104–113) on the Faraday effect and by Achyuthan (pp. 162–167) on photoconductivity, both largely experimental.

Many of the experimental data recorded in this substantial volume of about 200 pages, illustrated by many plates and drawings, are of great interest, actual or potential. The attempted interpretation of these data, however, in terms of the Raman theories, cannot be convincing unless the criticisms already made by workers outside the Bangalore Institute are answered in full and in such a way as to satisfy the critics. Instead, the Bangalore workers would sometimes seem to turn to fresh experimental approaches in the search for further support for their theories, leaving the original criticisms unanswered. The inevitable result is that full recognition is withheld from what is obviously an enthusiastic and hard-working research team, engaged on a problem of great interest and importance.

W. H. TAYLOR

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OBITUARIES

Sir Almroth Wright, K.B.E., C.B., F.R.S.

ALMROTH EDWARD WRIGHT was born in Yorkshire in 1861, the second son of the Rev. C. H. H. Wright, a distinguished Ulster divine, by his wife Ebba, daughter of Nils Almroth, governor of the Swedish Royal Mint. He was educated at first in Germany and France and then privately in Belfast before going up to Trinity College, Dublin, where he graduated B.A. in 1882 and M.B., B.Ch. in 1883, proceeding to the M.D. degree in 1889. After working at the Universities of Leipzig, Strasburg and Marburg, he returned to England to become demonstrator in pathology in the University of Cambridge, where he took the B.A. degree in 1888. In 1889 he became demonstrator in physiology in the University of Sydney, returning three years later to become professor of pathology at the Army Medical School at Netley, where he remained until 1902.

Following up the tentative essays of Pasteur, Haffkine and Pfeiffer, Wright originated in 1896 the system of anti-typhoid inoculation. The results of this prophylactic measure in South Africa and India were so striking that before the outbreak of the First World War it had been made standard practice in the British Army. In 1898 Wright went to India as a member of the Plague Commission. In 1902, following differences with the War Office about anti-typhoid inoculation, he resigned his professorship at Netley and became pathologist to St. Mary's Hospital, London. Here he founded the Inoculation Department, of which he was the first principal. Here, too, he originated the system of therapeutic inoculation for bacterial infections (vaccine therapy) and numerous methods for measuring the protective substances in the blood, notably the opsonic index. He held also a professorship of experimental pathology in the University of London.

In 1914 Wright published the results of his investigations into the incidence, prevention and treatment of pneumonia among the natives employed in the South African mines.

During the First World War, Wright served as consulting physician to the British Forces in France, and devoted himself to studying the immunology of wound infections and to combating the ravages of gas gangrene. This was his last great research.

By 1925, all Wright's important contributions to bacteriology and immunology had been made. He worked as assiduously and devotedly as ever, but in unpropitious circumstances. All the problems susceptible of solution by the methods which Wright had devised and of which he was an acknowledged master had been solved, and the questions awaiting solution could be attacked only by new methods and a new approach. Moreover, the team which he had trained, inspired and led, and which had contributed in no small measure to his triumphs, had disintegrated: some had turned from immunology to other subjects; some had sought greater scope and brighter prospects elsewhere. Other pupils and assistants he had, but times had changed, and they lacked the faith and industry of their predecessors; and, having set their hands to the plough, sooner or later turned back.

In these circumstances, Wright tended to direct his attention more and more to philosophy and, in particular, to logic. The subject had always fascinated him and, as early as 1895, he had contributed to *Brain* a paper "On the Nature of the Physiological Element in Emotion". This contribution he afterwards had reprinted to "demonstrate that some of the problems treated of in this Book have been actively simmering in my mind for at least fifty years". He determined, then, now that opportunity offered, to produce a book of technique for the abstract thinker which should do for him what his book "The Technique of the Teat and the Capillary Glass Tube" had done for the laboratory worker. He felt the inadequacy of formal logic and the sterile ratiocinations of the Schoolmen, of which he says: "And if we were dealing with a syllogism, there would in every case be something which rendered it non-coercive—I am thinking of the fact that we are never in a syllogism given convincing evidence that the major and minor premises can be safely accepted". He proposed to supplement syllogistic induction by a series of criteria of truth, which could be applied to logical propositions as the crucial experiment is applied to physical phenomena. This project, in the course of time, assumed many forms and underwent many vicissitudes, to emerge finally as "Alethetropic Logic, or the Logic which searches for Truth", of which the preliminary volume, "Prolegomena to the Logic which searches for Truth", had appeared in 1941. To this book, which Wright regarded as his *magnum opus*, he was putting the finishing touches: in fact, he was working upon it within a few hours of his death on April 30.

What manner of man was Wright? His intellect, naturally commanding, had, by wide reading, extensive travel and profound reflexion, become a precision instrument of the finest quality. It absorbed and assimilated with equal facility science, literature, law and philosophy, and made him, without apparent effort, a brilliant public speaker and a delightful conversationalist. His place as a pioneer worker and original thinker is assured. But he used his great gifts naturally and without ostentation, so that no one, were he never so young or so unsophisticated, was ever abashed or discomfited in his presence. In controversy, although he loved it, he was not at his best; and gave sometimes a totally erroneous impression of his character and intelligence. On matters of principle he was steadfast and unyielding, but in argument he often appeared elusive and even disingenuous, so that such verbal engagements were usually unsatisfactory and indecisive.

The outstanding trait in Wright's character was his kindliness. No one ever appealed to him in vain for help of any kind, and many were the beneficiaries of his secret munificence. The sight of suffering always affected him profoundly, and this compassion was a spur that ever urged him on. Other endearing traits he had in plenty: great personal charm and an impish sense of humour, unwearying patience and a temper either naturally equable or under complete control, undaunted pertinacity and an equanimity which neither failure nor success could shake.

It is customary, when writing of a great man, to say that we shall never see his like again; but this is literally true of Almroth Wright, for while heredity might play its part in producing his peer, the environment, in which alone so bold, fearless and uncompromising a spirit could flourish and attain full stature, has passed away. R. T. MUMMERY

Prof. Heinrich Kayser, For.Mem.R.S.

WAR conditions led to the fact that the death of Heinrich Kayser on October 14, 1940, at Bonn at the age of eighty-seven passed unnoticed in Great Britain.

Born at Bingen on March 16, 1853, Kayser was educated at the Sophieen Gymnasium in Berlin and at the University of Strassburg under Kundt; there one of his fellow students was Röntgen. He took his doctorate at Berlin and became an assistant to Helmholtz in 1879. He was introduced to spectroscopy in 1880 by Hagen, one of his fellow assistants, and at once became drawn to the subject, publishing his "Lehrbuch der Spektralanalyse" in 1883. In 1885 he was appointed to the Technische Hochschule in Hanover, where he had as his colleague Runge, and as assistant Paschen. The nine years at Hanover, before he succeeded Hertz at Bonn, were very fruitful in tables of the spectra of the different elements, of which the best known was the photographic map and table of wave-lengths for the spectrum of the iron arc from 2500 to 6600 A., published in collaboration with Runge.

The work on which Kayser spent most of his twenty-five years at Bonn—his life-work—was the "Handbuch der Spectroscopie", of which the sixth volume came out in 1912. It was a stupendous undertaking, a compendium of all that was known in spectroscopy. The subject had grown so much while the work was in progress that the proposed volume on astrophysical applications got squeezed out, and two supplementary volumes were needed and brought out with the aid of Konen and others after Kayser had passed the age of eighty. Other valuable contributions in his later years included a "Tabelle der Hauptlinien der Linienspektren aller Elemente"; but the "Handbuch" remains as his monument.

Kayser's wide knowledge of languages was a great help to him in his work and was combined with a passion for travel, in part inherited from his parents. He was one of the founders of the International Solar Union in 1904 and attended its meetings regularly; he was the genial host at Bonn for the meeting in 1913. Though he was one of the first to be co-opted, when that became possible, on to a commission of the International Astronomical Union, that of Standard Wave-lengths, he never attended its meetings. He was elected a foreign member of the Royal Society in 1911 and was present and spoke at the two hundred and fiftieth anniversary gathering in 1912; of this meeting he said in his autobiography, written at the age of eighty-three: "Überall zeigt sich als alteingewurzelt Tradition, Reichtum, Macht; und das wirkt mehr als alle Reden".

F. J. M. STRATTON

Dr. J. D. Falconer

Dr. John Downie Falconer, geologist and geographer, died at Hounslow on April 16. The news of his death came as a shock to his friends, since he was present, and in apparent good health, at the annual meeting of the Geological Society just a month before.

Falconer was born in Midlothian in 1876 and was educated at the Universities of Glasgow and Edinburgh. During 1901–4 he was assistant to Prof. James Geikie, and he then went to Northern Nigeria as principal of the Imperial Institute Mineral Survey, returning to the University of Glasgow to take up the appointment of lecturer in geography in 1911. He went back to Northern Nigeria in 1916 as an assistant district officer, but in 1918 he was made director of Geological Survey for Nigeria, a post he held until 1927. During 1928–34 he was geologist to the Republic of Uruguay.

Dr. Falconer was the author of many papers and official bulletins, and of works in lighter vein on his travels in Nigeria and Uruguay. In 1937 he published a book on Darwin in Uruguay. The work for which he is best known and will long be remembered with appreciation is that relating to the physiography, geology and mineral resources of Nigeria, the results of which are in part incorporated in his "Geology and Geography of Northern Nigeria". This book and the accompanying map remain a valuable source of information, and the theoretical discussions, while not always in accord with modern views, have served as a great stimulus to further investigation. His work was characterized by thoroughness and wide knowledge of his subject, and it stands as a tradition and an inspiration to the Geological Survey of Nigeria, of which he was the first director. He was responsible for the earlier issues of the bulletins of the Geological Survey of Nigeria and the accompanying geological maps, which were of considerable scientific and economic value, especially as regards the tin resources of Nigeria.

The Geological Society awarded Dr. Falconer the Lyell Fund in 1920, and he served on the Council of the Society during the period 1927–29.

His loss is deeply felt by many friends and former colleagues, and by the mining community of Nigeria.

F. Dixey

Prof. Fritz Weigert

The death of Prof. Fritz Weigert on April 13 was a loss to science, and came as a sad blow to a wide circle of friends and colleagues who admired him as much for his personal charm and wide culture as they respected him for his academic achievements.

Fritz Weigert was born in Berlin in 1876, where he received his education as a chemist. While his early collaboration with such men as van't Hoff and Nernst in Berlin and Robert Luther in Leipzig no doubt had a profound influence on his life-work, the originality and highly individual character of his subsequent researches in photochemistry and related fields must be attributed to his own peculiar gifts, both in the brilliant improvisations of technique and in his imaginative approach in the interpretation of results and formulation of new theories.

In 1914 he was appointed professor of photochemistry at Leipzig, in succession to Luther, and in his inaugural lecture he put forward the courageous, if unorthodox, suggestion that in a new field of research (as the study of photochemical reactions then was), rigid systems of interpretation, even if afterwards proved to be wrong, are justified on the grounds that new experimental methods may thereby be disclosed and new angles of approach discovered, which would be a stimulus for further research. In Weigert's hands, this double-edged weapon undoubtedly bore rich rewards in his researches, though it may also have been in part responsible for the tardiness in acknowledging all the credit due to him.

After thirty years of research in physical chemistry in Germany, Fritz Weigert had, with the advent of Nazism, to seek refuge in a foreign land; and so began his second career, at the age of sixty, as director of the Physico-chemical Department of the Cancer Research Institute, Mount Vernon Hospital, at Northwood, Middlesex. It is hard to say whether the choice of cancer research was entirely dictated by circumstances, or whether it was not partly influenced by his heritage, for he was the nephew of two of the most distinguished pathologists of the last century—Paul Ehrlich and C. Weigert.

The study of the metabolism of the carcinogenic hydrocarbon, 3 : 4-benzpyrene, by the application of fluorescence spectrography, which Weigert undertook in his new position, was ideally suited for a man of his ability, and he threw himself into the problem with the energy and enthusiasm that a man half his age might have envied. His contributions to this field were significant and stimulating, and characteristic of the man, both in the sphere of technique (as in his adaptation of fluorescence spectrography for the study of hydrocarbons adsorbed on alumina columns) and in the realm of interpretation of results.

Fritz Weigert was, to the end, a keen and active worker, and, despite his deafness, a witty and lively conversationalist. His death was unexpectedly sudden, as he himself would no doubt have wished it to be.

I. Berenblum
H. von Halban

Alice Lady Avebury

The death of Alice Lady Avebury at High Elms, Downe, Kent, on March 11, at the age of eighty-five, removed an important link between the two leading prehistorians of the Victorian period. She was the daughter of General Pitt-Rivers and the wife of the first Lord Avebury. From her father she inherited much—his clear intellect, his orderly ways and his imperious manner. She was Lord Avebury's second wife, being married to him in 1884 while he was still Sir John Lubbock, member of Parliament, banker, author of "Prehistoric Times" and the father of Bank-Holidays. The Lubbock home, at High Elms, was a centre where the celebrated men of science of the Victorian period came to spend week-ends. Lady Avebury was an ideal hostess, and around her many new friendships were formed. She was a woman of wit and of beauty, never afraid to give utterance to what she really thought and believed. She was on the most friendly terms with the Darwin family at Down House, and when Darwin's home passed into the custody of the British Association she continued her association with that remarkable place. She welcomed the transfer of the historic Lubbock home of High Elms with its park and woods to London's Green Belt; indeed, she took the initiative in this transfer. Her daughter, the Hon. Mrs. Ursula Grant Duff, continues the Avebury interest in social science.

Arthur Keith

NEWS and VIEWS

Prof. Carl Størmer

On May 20 the University of Oxford conferred the degree of D.Sc., *honoris causa*, upon Prof. Carl Størmer, who later on the same day delivered the Halley Lecture on "Polar Aurora in Southern Norway". The presentation speech by the Public Orator at the degree ceremony was in Latin elegiac verse, with a prose addendum which included the remark that Prof. Størmer richly deserved a gown equally worthy of the Goddess of Dawn and the Goddess of Learning. The verse described an imaginary interview between the Public Orator and the Goddess Aurora, who was visible (so it seemed) in the northern skies at night during the recent hard weather, and appeared to have deserted her usual haunts and her husband Tithonus. Aurora bade the Orator to improve his knowledge of celestial phenomena (and his opinion of her) by consulting the eminent Norwegian astrophysicist Prof. Størmer, whose pride it was to have mastered the nature of her counterfeit, the Aurora Polaris, determining the situation, form, motion and spectrum of this phenomenon. He could also speak with authority on the 'mother of pearl' clouds high in the stratosphere, and in addition had long studied the motion of charged particles arriving at the earth from the sun.

Prof. Størmer, now emeritus professor of pure mathematics at the University of Oslo, besides making distinguished contributions to that subject, and applying it to the study of the motion of charged particles in the earth's magnetic field, thus explaining many remarkable observed characteristics of the Aurora Polaris, has for more than a third of a century been the foremost leader and organiser of auroral observation by simultaneous photography from two or more well separated stations in Norway. This work has brought a rich harvest of increased knowledge of the Aurora Polaris, presenting a fascinating set of problems for theoretical geophysicists. As by-products of his observing organisation, Prof. Størmer has also made important additions to our knowledge of 'mother of pearl' clouds and of winds in the upper atmosphere, as indicated both by such clouds and by meteor trails.

British Rubber Producers' Research Association: Dr. Geoffrey Gee

Dr. Geoffrey Gee, who has recently been appointed director of the British Rubber Producers' Research Association's extensive laboratories at Welwyn, has made important contributions to our knowledge and understanding of the properties of long-chain polymers, especially rubber. His early work at Cambridge dealt with the kinetics of polymerization reactions both in bulk and at interfaces. More recently, he has undertaken a critical examination of the thermodynamics and statistical mechanics of systems involving rubber and related polymers. The last decade has witnessed striking advances in the mathematical treatment of the behaviour of long-chain molecules, but there has been a dearth of exact experimental data, thus precluding any development of the statistical mechanical treatment. Dr. Gee with his collaborators has been able to provide reliable and extensive experimental data which have permitted them in turn to make advances in the theoretical treatment. The determination of the molecular weights of rubbers and the inter-relationship of the different methods; the connexion between the heats of mixing of rubber and liquids and their cohesive energy densities constitute two of the more important sections of his work.

Sir Edwin Ray Lankester (1847–1929)

The greatest morphologist of his generation, Sir Edwin Ray Lankester was born a century ago, on May 15, 1847. He was the son of a medical man, he taught medical students, and throughout his career delighted in making zoology serve medicine. When he graduated at Oxford in 1870, biology was still regarded as an apanage of medicine. Those desirous of devoting their lives to the pursuit of comparative anatomy, zoology or physiology had to seek a post at a medical school. It was Huxley who urged budding biologists to seek out independent paths for themselves. In 1874, Ray Lankester, then aged twenty-seven, was appointed to the Jodrell chair of zoology at University College, London. In 1891 he became Linacre professor of comparative anatomy at Oxford, returning to London two years later to succeed Sir William Flower as director of the British Museum (Natural History). On his retirement at the age of sixty he was created K.C.B. A tireless worker and a prolific writer, Ray Lankester's individual contributions to zoology were numerous and distinguished; yet he was at home in almost all fields of biological knowledge. A massive yet nimble mind dwelt in a massive frame. Impatient, utterly fearless, sociable, charming, with a deep booming voice, Ray Lankester was one of the most brilliant and imaginative lecturers in British science. He died on August 15, 1929.

Linnean Society of London: Anniversary Meeting

At the anniversary meeting of the Linnean Society of London held on May 24, the president, Prof. G. R. de Beer, announced that a message of congratulation had been addressed to H.M. Queen Mary, honorary member of the Society, on the occasion of her eightieth birthday, and that H.R.H. the Princess Elizabeth had been pleased to accept the honorary membership of the Society. He delivered a presidential address on "How Animals Hold Their Heads". The Linnean Gold Medal was awarded to Prof. Maurice Caullery, of Paris, who was present to receive it. The following were elected officers for the session 1947–48: *President*, Prof. G. R. de Beer; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. Malcolm A. Smith (Zoology) and Dr. B. Barnes (Botany). The new Members of Council were Prof. G. D. Hale Carpenter, Mrs. Vera Higgins, Mr. E. W. Mason, Dr. W. E. Swinton and Dr. George Taylor. The following were elected foreign members: Prof. A. Chevalier, Muséum d'Histoire Naturelle, Paris; Prof. C. M. Child, University of Chicago; Prof. E. Fischer-Piette, Laboratoire de Malacologie, Paris; Prof. E. Hultén, Natural History Museum, Stockholm; Dr. G. G. Simpson, American Museum of Natural History, New York. In addition, W. G. Mackenzie, curator of the Chelsea Physic Garden, and A. W. Stelfox, of the National Museum of Ireland, were elected associates *honoris causa* of the Society. During the proceedings a film entitled "The Development of the Sperm Cells of the Grasshopper" was shown, with a commentary by Dr. C. D. Darlington.

Scientific Research Organisation in Great Britain

In the first A. D. Little Memorial Lecture, "Science, Industry and Government", now published in *Technology Review* (February 1947), Sir Edward Appleton, speaking before an American audience, reviewed British experience in the organisation of research. Success in the organisation of science in the war effort has led the public to conclude that science should play a similar part in solving the problems of peace. Ultimately the provision of work, homes, food, health and safety from aggression for all depend for solution on the maintenance of the same kind of partnership between government, science and industry which grew up during the War; and, referring to the brilliant team-work during the War, Sir Edward pointed out that the result of the policy pursued was that the research establishments of the Services were strengthened by the addition of many brilliant minds from the universities, while the research teams in industry were left intact and ready to attack, as composite units, the problems allotted to them. One of the most striking results of war-time experience in Britain was the brilliant success of university research workers in solving war problems entirely remote from their peace-time interests. University conditions appear to ensure the maintenance of the mental adventurousness and lively imagination so necessary for scientific progress; and in planning the future of the Scientific Civil Service in Britain, an attempt is being made to secure conditions that encourage these qualities.

The most successful applications of science in our war-time experience resulted from the closest possible collaboration between the men of science and the military staff; the field in which the scientific worker can usefully operate extends far beyond the laboratory. Free fundamental research had, however, been almost entirely in abeyance in Britain, and we must recognize the return of peace by changing our priorities. In many fields, we have been living on our scientific capital, which now stands urgently in need of replenishment. Pointing out that scientific research in the universities is of relatively modern growth, Sir Edward referred to the accepted university tradition that teachers of scientific knowledge should also advance that knowledge. Although carried out in a spirit of pure inquiry, this free fundamental research has shown a surprising capacity for being useful. The universities are also the source of the trained scientific workers for university, government and industrial laboratories, and in this connexion Sir Edward referred to the outstanding importance of the exceptional man. Most of the really great advances in science have been accomplished by small teams of workers led by a man with ideas, and Sir Edward believes that a vital task is to see that such men lack neither disciples, assistants nor equipment.

Magnetic Recording of Sound

A lecture on "Developments in Magnetic Recording" was given by Mr. P. T. Hobson to the British Sound Recording Association on March 27, with demonstrations of the wire-recording machine now in production and available in small quantities for non-entertainment purposes. A model of a high-grade instrument shows that the technique of wire-recording has risen so rapidly in recent years that the quality of reproduction obtained can be classed as high, if not higher, than with the best disks and the Philips-Miller system. The comparative cheapness of the wire, the possibility of erasure and the immediate rewind makes magnetic recording attractive for many purposes, apart from the straight and protracted reproduction of music. Ever since Poulsen discovered the possibility of magnetic recording nearly fifty years ago, designers have been misled by the erroneous idea of the exact process of magnetization. Research by the Armour Corporation of the United States and also in Britain has led to the selection and heat-treatment of the steel wire so that a diameter of only 4 mils and a velocity of 24 in. a second can give high-quality reproduction with a signal-to-noise ratio of some 60 decibels. The material is a stainless steel, heat-treated with a current to bring it into the austenitic condition, and with a maximum ratio of the coercive force to remanence, this being the condition for minimizing the almost complete self-demagnetization of the disk-like magnets of which the wire seems to be comprised at the highest frequencies and shortest wave-lengths with tolerable loss.

Mr. Hobson gave an exposition of the theory of such longitudinal magnetization and explained the great advantage of polarizing the magnetizing current with a large component of high carrier-frequency current, which is also used for erasing. The standard machines use reels for recording for a total of 66 minutes, but sufficient quality is left at lower speeds for a total time of eight hours. The non-entertainment machine can run at various speeds for transmitting or receiving high-speed alternating-current signals, while the proposed music-machine not only uses a capstan on which ordinary disks can be played, but also includes an ingenious mechanism which automatically wraps the wire round the capstan for recording or reproducing from wire, thus making the machine substantially foolproof. If the wire should break, a knot can be tied in it.

Research in the South Pacific Area

An important outcome of the South Seas Conference at Canberra, January 28–February 6, 1947, attended by delegations representing the Governments of Australia, France, the Netherlands, New Zealand, Great Britain and the United States, which administer non-self-governing territories in the South Seas, was the signing of an agreement establishing the South Pacific Commission, which will seek to promote the economic and social welfare and advancement of two million people in the South Pacific. The Commission is to appoint an advisory research council of persons distinguished in fields of research within the competence of the Commission, including some full-time appointments of persons highly qualified in the fields of health and economic and social development, together with a full-time director of research. The functions of the research council include the maintenance of a continuous survey of research needs in the territories within the scope of the Commission, and making recommendations to the Commission on research to be undertaken; arranging for the prosecution of research studies approved by the Commission, using existing institutions where appropriate and feasible; and co-ordinating the research activities of other bodies working within the field of the Commission's activities, and availing itself, where possible, of the assistance of such bodies. The council may also appoint technical standing research committees to consider problems in particular fields of research, and, with the approval of the Commission, *ad hoc* research committees to deal with special problems.

Grading of Scientific Films

A MEMORANDUM on "The Classification, Appraisal and Grading of Scientific Films" issued by the Scientific Film Association, 34 Soho Square, London, W.1, has been drawn up by the Association after consultation and discussion with interested bodies in Britain and in other countries. It is primarily concerned with films of scientific interest for adult audiences; but the method of appraising and grading recommended should be applicable to all types of documentary films. A specimen card on which it is recommended the content and lay-out of the data concerning each film should be standardized is appended, together with a definition of terms commonly used in a special sense by the film industry and film critics. Notes are included on the synopsis of the content of each film, which should be brief and objective, as well as on the determination of accuracy and comprehensiveness within the terms of reference laid down by the producer and with reference to the purpose of the film, while the grading of the film in relation to the types of audience likely to see it is considered separately. The organisation of the viewing panel, the appraisal group meetings, the appraisal standing committee and the records to be kept are dealt with in the next section, which includes a specimen viewers' report form. The Association hopes that the principles suggested here will be applied wherever films are appraised. It has earned the gratitude of scientific workers who may need to use such films, as a step towards a standard procedure for film documentation which, if accepted internationally, would be of immense value to all who make or use educational films.

Journal of Glaciology

THE Association for the Study of Snow and Ice, formed in 1936, has grown into the British Glaciological Society, which this year has started the publication of the *Journal of Glaciology*. There is room for such a publication not only to produce the papers read before the Society itself but also to consider many practical aspects of snow and ice. Without undue overlapping, it is clearly desirable to make contacts with various aspects of geomorphology, meteorology and geography. The *Journal* (price 7*s*. 6*d*.) is under an editorial committee consisting of Messrs. G. Seligman, W. L. S. Fleming, B. Roberts and R. Moss, and its present address is care of the Royal Geographical Society, London, S.W.7. The first number has varied contents following an introductory note by Prof. H. W. Ahlmann. Mr. G. Seligman explains Dr. R. Streiff-Becker's theory of extrusion flow in glaciers, and the Rev. W. L. S. Fleming discusses some of the Antarctic glaciological researches of Byrd's Third Antarctic Expedition. There are also a number of short articles and the first instalment of a list of recent glaciological publications, in the main non-polar works. The *Journal* promises to find a place among scientific periodicals of value.

U.S. Chemical Corps Advisory Committee

AT the request of Major-General Alden H. Waitt, chief of the U.S. Chemical Corps, an advisory committee has been appointed to serve as a liaison group between the Corps and the chemical profession and industry, and to provide advice on scientific and personnel matters in connexion with Chemical Corps research and development. The committee is as follows: Dr. W. Albert Noyes, jun., president of the American Chemical Society and head of the department of chemistry in the University of Rochester (*chairman*); Prof. R. Adams, University of Illinois; Prof. A. C. Cope, Massachusetts Institute of Technology; Colonel Bradley Dewey, of Cambridge, Mass., formerly U.S. Rubber Administrator; Dr. Willard H. Dow, president and chairman of the Dow Chemical Co., Midland, Mich.; Prof. Vincent du Vigneaud, Cornell University Medical College; Prof. Louis F. Fieser, Harvard University; Dr. Per K. Frolich, co-ordinator of research of Merck & Company, Rahway, N.J.; Prof. H. F. Johnstone, University of Illinois; Sidney D. Kirkpatrick, chairman of the American Section of the Society of Chemical Industry; Dr. Walter Kirner, director of the Chemical and Biological Coordination Center of the National Academy of Sciences; Dr. Stanford Moore, Rockefeller Institute for Medical Research; R. L. Murray, vice-president and technical director of the Hooker Electrochemical Co., Niagara Falls, N.Y.; Prof. Charles C. Price, Notre Dame University; Prof. Glenn T. Seaborg, University of California; Prof. Harold C. Weber, Massachusetts Institute of Technology; and Dr. Robert E. Wilson, chairman of the board of directors of the Standard Oil Co. of Indiana.

Chinese Fisheries

AFTER many years of devastation China is now, with the help of the United Nations, endeavouring to bring about the rehabilitation of her basic industries. Not least in importance is the fishing industry, and a Chinese Fisheries Research Institute has been formed for the purpose of carrying out investigations necessary to guide the Chinese fisheries industry during the difficult period of the immediate future and to provide data upon which to base enlightened fisheries administration. Implementation of this programme is severely hampered by lack of books and equipment, and an appeal has been launched for donations of any suitable books, journals and other periodicals that individuals or institutions may be able to spare. As the Institute possesses little more than a measuring-board in the way of equipment, donations of scientific apparatus will also be welcomed. All gifts and offers of help should be sent to the Director, Fisheries Research Institute, Room 402, National City Bank Building, 54 Kiukiang Road, Shanghai, China.

Quality Control Methods in Canada

A SPECIAL committee has just been established by the National Research Council of Canada to promote the application of mathematical methods in the treatment of certain industrial production problems. Members of the committee include specialists in statistical quality control procedures, in sampling surveys, in the design of experiments, and in biometry or the statistical study of variation; the chairman is Dr. J. W. Hopkins, National Research Council, Ottawa. The committee will assist Canadian users of mathematical statistical methods by consultation and advice respecting specific technical problems; it will also support research in this field by qualified workers, and provide a means of liaison with technical groups in Canada and abroad.

International Union of Biological Sciences: Fellowships

APPLICATIONS are invited for the following fellowships: two at the Zoological Station, Naples; one at the Marine Biological Station, Roscoff (France); one at the Central Bureau for the Cultivation of Fungi, Baarn (Netherlands). These fellowships are open to graduate students of biology in its widest sense from universities all over the world. The value of each fellowship will be 750 dollars for students from Europe, and 1,000 dollars for students from outside Europe (travelling and lodging expenses included); duration of stay at least eight months. Applications, giving full information concerning the proposed investigations, must reach the executive committee of the International Union of Biological Sciences, c/o Prof. M. J. Sirks, Genetisch Instituut, Huis de Wolf, Haren (Gron.), Netherlands, before October 1, 1947.

James Hutton Memorial

THE Royal Society of Edinburgh, in conjunction with the Royal Physical Society, the Edinburgh Geological Society, the Geological Society of Glasgow, and H.M. Geological Survey (Scotland), has appointed a committee to organise an appropriate commemoration of the 150th anniversary of the death of James Hutton, "the Father of Modern Geology". Among other items it is proposed to erect a granite panel, suitably inscribed, at the site of Hutton's unmarked grave in Greyfriars Churchyard, Edinburgh. Subscriptions are invited to defray the cost of this memorial. Any sum in excess of the amount required will be applied towards the cost of a publication, which is at present under consideration. Subscriptions, not to exceed *5s.*, should be sent to the Treasurer, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, for the James Hutton Memorial Fund.

The Night Sky in June

FULL moon occurs on June 3d. 19h. 27m., U.T., and new moon on June 18d. 21h. 26m. The following conjunctions with the moon take place: June 2d. 00h., Jupiter 0·02° N.; June 16d. 08h., Mars 0·7° N.; June 17d. 10h., Venus 1° S.; June 20d. 14h., Mercury 4° S.; June 21d. 11h., Saturn 4° S.; June 29d. 01h., Jupiter 0·3° S. Mercury is an evening star, setting at 21h. 43m. on June 1 and at 21h. 06m. on June 30. It attains its greatest eastern elongation on June 17 and is stationary on June 30. Venus is a morning star, rising at 3h., 2h. 44m., and 2h. 41m., at the beginning, middle and end of the month respectively. More than 90 per cent of the disk appears illuminated, and the stellar magnitude of the planet is $-3·3$. Mars rises in the early morning hours but is too close to the sun for favourable observation. Jupiter, in the constellation of Libra, can be seen until the early morning hours, setting at 3h. 06m. on June 1 and at 1h. 05m. on June 30. Saturn is visible in the early portion of the night, setting at 23h. 39m. and 21h. 54m. at the beginning and end of the month, respectively. Occultations of stars brighter than magnitude 6 are as follows: June 6d. 01h. 33·6m., φ Sgtr. (*D.*); June 6d. 02h. 50·8m., φ Sgtr. (*R.*). The latitude of Greenwich is assumed and *D.* and *R.* refer to disappearance and reappearance, respectively. A partial eclipse of the moon, partly visible at Greenwich, occurs on June 3. The moon enters the umbra at 18h. 56·2m. and leaves it at 19h. 34·2m. The eclipse will not be very spectacular, as its magnitude is only 0·024. Summer solstice occurs on June 22d. 06h.

Announcements

THE Very Rev. Alan Campbell Don, dean of Westminster, and Sir Robert Robinson, president of the Royal Society, have been elected honorary members of the Institution of Civil Engineers.

DR. J. H. QUASTEL, director of the Unit of Soil Metabolism of the Agricultural Research Council, has been appointed to the chair of biochemistry at McGill University, Montreal; he will be associate director of the newly created Institute for Special Research and Cell Metabolism and will also take charge of the Enzyme Division of the Institute. He is taking up his new duties on September 1.

WARNER MEMORIAL MEDALS for 1947 of the Textile Institute have been awarded to D. A. Derrett-Smith and Dr. D. A. Clibbens. These Medals were founded in 1930 in memory of the late Sir Frank Warner, formerly president of the Institute, and are given for original investigation published in the *Journal* of the Institute.

DR. HERMAN F. MARK, director of the Institute of Polymer Research and professor of organic chemistry at the Polytechnic Institute of Brooklyn, New York, has been invited to the Chair Francqui at the University of Liège for the academic year 1947–48. The Chair Francqui is a guest professorship involving the delivery of lectures at several Belgian universities for a period of about six months. Previous occupants of the chair have been P. Debye, H. S. Taylor, A. St. Györgyi and Victor Henry.

DR. E. EMMET REID, emeritus professor of chemistry in the Johns Hopkins University, research adviser to several colleges and universities in the southern United States, has been awarded the Herty Medal for outstanding contributions to chemistry in that region. The Herty Medal is given by the Chemistry Club of the Georgia State College for Women on the recommendation of the Georgia Section of the American Chemical Society. The late Dr. Charles H. Herty, after whom the medal is named, and who was president of the Synthetic Organic Chemical Manufacturers Association during 1921–26 and twice president of the American Chemical Society, was born on the site of the College campus.

MR. W. V. D. PIERIS, geneticist, left the service of the Coconut Research Scheme (Ceylon) in September, 1946. The designation of the post has been altered to botanist, and the board of management has appointed thereto Dr. T. S. Raghavan, formerly professor and head of the Department of Botany, Annamalai University, Annamalainagar, South India. Dr. Raghavan's interests have been mainly cytological and cytogenetical. Recently he has synthesized a new species of *Sesamum* by hybridization between *S. orientale* and *S. prostratum*. The sterile hybrid has been made fertile through the induction of amphidiploidy by artificial means. In the hybrid has been incorporated the perennial habit of the *prostratum* parent.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Quantum Theory of Liquids

A SHORT account of a general kinetic theory of liquids which we have recently published in *Nature*[1] ended with the enumeration of a series of problems yet unsolved which were our next aim. The most important of these generalizations is the quantum theory of liquids, because of the strange properties observed in liquid helium II.

An attempt to formulate such a theory has been made by Landau[2], in which he transcribed the hydrodynamical equations into operator equations. The meaning of these is obscure, and Landau makes no application of them apart from the general remark that in quantum liquids there will be 'phonons', which correspond to quantized acoustical waves, and 'rotons', which correspond to quantized vortex motion and will have a set of discrete states like those of the angular momentum in ordinary quantum mechanics. This idea is then used as the basis of some plausibility considerations by means of which he tries to explain some of the characteristic properties of He II. Landau's main result, the existence of two distinct velocities of sound, however, rests on quite different assumptions.

We cannot accept this assortment of unrelated suggestions as a solution of the problem of 'quantum liquids'. The correct approach consists, of course, in a direct application of the laws of quantum mechanics to a dense assembly of particles. There are no new principles involved (just as in our classical kinetic theory of liquids) but only mathematical difficulties to overcome, which are mainly due to the close packing. We found that the proper tool for this purpose is the 'density matrix', introduced by von Neumann[3] and Dirac[4] and studied in detail for equilibria by Husimi[5]. It is a function of two different configurations $X = (X_1, X_2, \ldots X_N)$ and $X' = (X'_1, X'_2, \ldots X'_N)$ of all N particles, $\rho_N(X, X')$, and it replaces the distribution function of co-ordinates X and velocities ξ, $f(X, \xi)$, which is used in classical theory. Its change in time depends on the differential equation

$$\hbar \frac{\partial \rho}{\partial t} = W\rho - \rho W, \qquad (1)$$

where W is the energy operator and the products are matrix products according to the ordinary laws of quantum theory.

We proceed now, just as in the classical theory, by forming a set of distribution functions

$$\rho_1(X_1, X'_1),\ \rho_2(X_1, X_2, X'_1, X'_2),\ \ldots,\ \rho_N(X_1 \ldots X_N, X'_1 \ldots X'_N),$$

where each function is obtained from the following one by taking the trace with respect to one pair of variables. It can be shown that the function $\rho_q(X,X')$ satisfies an equation which differs from (1) only by adding a 'statistical term' quite analogous to that appearing in the classical theory. The diagonal terms of ρ_1 represent the number density $n_1(X_1)$, those of ρ_2 the radial distribution function $n_2(X_1,X_2)$, and it can be shown that just as in the classical theory all thermodynamic properties can be expressed in terms of these two functions.

The hydrodynamical equations (including the equation of continuity and that of energy transport) can then be derived in a straightforward way. Thus we obtain the main result, that the quantum laws governing the behaviour of matter in bulk are identical with the classical laws, in sharp contradiction to Landau's formalistic approach. Quantum theory appears only in the atomistic interpretation of the quantities appearing in the equations. It is in this interpretation where very great deviations from the ordinary behaviour of a 'classical' liquid are found. We enumerate a few of these below.

The dynamical equations contain a temperature T_1, defined by the mean kinetic energy, which is not identical with the equilibrium temperature T, defined as the integrating denominator of the entropy. It is the gradient of T_1 which determines the flux of energy. Hence it must be expected that heat transfer does not depend in the usual way on differences of temperatures T measured by thermometers. This makes the properties of He II at once appear less paradoxical.

In the same way, the pressure p_1, the gradient of which determines the acceleration of mass, is not identical with the thermodynamical pressure p, defined as the negative derivative of the free energy with respect to volume. Hence differences of ordinary pressure will not have the effect expected from the usual theory. Again, the application to He II is obvious.

Concerning the dynamical constants, the coefficients of viscosity and thermal conductivity, it can be shown that they are represented by exactly the same formulæ as in the classical theory. Each consists of two parts, a 'kinetic' one depending on the distortion of the velocity distribution by the flux, and a 'potential' one, depending on the distortion of the radial distribution function n_2. The first part alone appears in ideal gases, but is negligible in liquids. The anomalies in liquid helium are therefore presumably due to the properties of n_2, which for low temperatures are indeed quite different from those in the classical domain. This has been shown by detailed calculations made by one of us (H. S. G.) for the extreme case $T = 0$. At high temperatures the nearest approach of two particles is determined by repulsive forces; as the radial velocity vanishes at this distance, there is a considerable probability of finding particles just above this distance, and none a little below. Near the absolute zero, however, the velocities are small, hence the de Broglie wave-length is large compared with the range of the forces; no scattering takes place, but the velocity is increased by the attractive forces, which reach to greater distances than the repulsive forces. Hence the probability of finding particles at a given distance (which is reciprocal to the velocity) decreases from a larger distance, quite independently of the ordinary collision diameter. All physical properties expressed by integrals over functions which contain n_2 as a factor will therefore show anomalies at very low temperatures. For the case of viscosity these results are in agreement with an interpretation suggested by R. Fürth, which he explains below.

The main problem for a quantitative theory is the explanation of the thermodynamical discontinuity separating normal He I from abnormal He II. For this purpose the temperature-dependence of n_2 has to be studied; investigations of this question are in progress (H. S. G.). This function n_2 is also obtainable by experiments with X-rays. The measurements published by Keesom and Taconis[6] and by Reekie[7], however, are much too inaccurate to allow a direct comparison with theory. We wish to direct the attention of the experimentalists to this important problem.

MAX BORN
HERBERT SYDNEY GREEN

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March 17.

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IT occurred to me some time ago that the phenomenon of superfluidity might be qualitatively understood on the basis of the concept of de Broglie waves in analogy to the Ramsauer effect. At sufficiently low temperatures and consequently very small thermal velocities, the de Broglie wave-lengths of the atoms ought to become large compared with the atomic dimensions; thus the collision cross-sections of the atoms must become very small, and hence all those phenomena which are due to atomic collisions should become insignificant. Consequently, if a substance can exist in the 'liquid state' at all at such a low temperature, it will have a vanishingly small viscosity. I have pointed out this idea in discussions and lectures on the subject in the past, but did not think fit to publish it without a proper quantum-mechanical treatment. It is very satisfactory that this has now been done by Born and Green quite independently, and that the result of their theory essentially confirms the qualitative picture outlined above.

R. FÜRTH

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Infra-Red and Raman Spectrum of *Cyclo*-octatetraene

As part of work on the structure and properties of *cyclo*-octatetraene, we have recently measured the infra-red spectrum between 2 μ and 20 μ of the liquid and vapour and the Raman spectrum of the liquid. The sample was prepared specially for this purpose, and purified by repeated re-crystallization. The infra-red spectra were measured with single- and double-beam recording spectrometers using prisms of rock salt, fluorite and potassium bromide. The Raman spectrum was excited with the mercury line 5461 A., which lies to the long wave-length side of the onset of absorption, and photographed with a spectrograph having a large glass prism giving high resolution and medium dispersion.

The following Raman displacements were found (cm.$^{-1}$): 193(9), 294(4), 372(7), ? 488(0), 874(8), 950(5), 1205(5), 1440(2), 1655(10), 1740(1), 2950(5), 3003(10).

The infra-red bands found with the liquid were as follows (cm.$^{-1}$): 675(v.s.), 762(w.), 802(v.s.), 849(v.w.), 875(v.w.), 890(v.w.), 913(v.w.), 944(s.), 968(m.), 993(w.), 1033(w.), 1098(v.w.), 1140(v.w.), 1208(m.), 1228(m.), 1405(m.), 1580(m.), 1642(s.), 1734(m.), 1754(m.), 1789(w.), 1879(w.), 1922(w.), 2008(v.w.), 2340(v.w.), 2749(v.w.), 2789(v.w.), 2834(w.), 2970(m.), 3009(v.s.), 3281(v.w.).

With the vapour, at temperatures up to about 80° C., some of the bands showed a well-defined contour. Thus the intense liquid bands at 802 and 675 cm.$^{-1}$ each split into a three-branch type at 793, 802, 813 cm.$^{-1}$ and 659, 670 and 681 cm.$^{-1}$. The liquid bands at 944 and 968 cm.$^{-1}$ also showed contour which seems to be of the same type; but the branches overlap and the exact position of the sub-maxima observed may not be directly useful. Each of the bands at 1208, 1228 cm.$^{-1}$ found with the liquid appears to show contour, but overlapping again obscures it. Near 3 μ, bands were found with the vapour at 2745(v.w.), 2834(w.), 2970(m.) and 3019(v.s.).

It is hoped to carry out a normal co-ordinate treatment of the results, and a complete discussion is therefore postponed; but the following comments may be made. First, while the Raman intervals obtained agree well with those recently reported by Lippincott and Lord, we have been unable to observe many of the weak displacements listed by these authors. It is peculiar that we failed to observe their fairly strong Raman interval of 249 cm.$^{-1}$; but as regards the remaining weak lines given by them it is possible that our exciting radiation was not intense enough to make them noticeable, in spite of repeated trials. On the other hand, it is possible that some of the weaker lines reported by them were due to residual impurities, but against this it is noteworthy that at least some of the intervals correspond to infra-red bands observed by us.

It is quite certain that a number of 'coincidences' between the Raman and infra-red spectra of the liquid occur. Unless the selection rules break down with the liquid, this would preclude the presence of a centre of symmetry. Other factors likely to indicate the exact selection rules which operate are less obvious. We have considered the results in terms of the structures D_{2d}, D_{8h}, D_{4h}, D_4 and D_{4d}, and while no clear decision seems possible, are inclined to think that they are in best agreement with the non-planar cradle type D_{2d} structure.

The solid polymer formed from *cyclo*-octatetraene on standing has also been examined in the infra-red. The presence of strong bands near 10 μ and 3 μ suggests that it contains hydroxyl groups.

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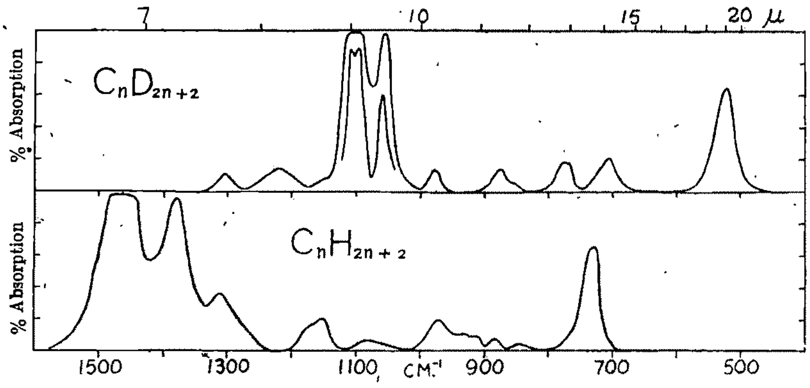
Infra-Red Spectrum of C_nD_{2n+2} and the 'Long-Chain Frequency' in Paraffins

THE most characteristic feature in the infra-red spectrum of any long-chain paraffin (C_nH_{2n+2}) is a strong band near 14 μ (725 cm.$^{-1}$). It was first noted by Coblentz[1], but Lecomte[2] and many other workers have directed attention to it, while an extensive investigation of hydrocarbons at Oxford and Cambridge[3] during the War showed that any molecule containing the group —$(CH_2)_n.CH_3$, in which n is equal to or greater than 3, possesses this band. So far as we are aware, no satisfactory interpretation of



this 'long-chain frequency' has yet been given[4], although it has been frequently assumed that it arises from a 'skeletal' vibration of the carbon atoms in the chain. The difficulty about this assignment is that the magnitude of the frequency is rather low for it to belong to a stretching mode of the carbon chain, and distinctly too high for it to be a deformation vibration. Recently, it has been suggested[5] that it is due to the overtone of a deformation vibration.

We have just investigated the infra-red spectrum of a fully deuterated long-chain paraffin and found, as expected, that all the bands well known to be due to vibrations of the hydrogen atoms (for example, those at 6·9 and 7·3 μ) were shifted to longer wave-lengths by approximately $\sqrt{2}$. However, we found that the band near 14 μ (725 cm.$^{-1}$) had also shifted and now appeared near 19 μ (522 cm.$^{-1}$), which corresponds almost exactly to lowering by $\sqrt{2}$. This proves conclusively that the 14 μ band in long-chain paraffins is not a skeletal frequency of the carbon chain but a vibration associated almost entirely with the hydrogen atoms. It seems most probable that it arises from a rocking vibration of the pairs of hydrogen atoms in the methylene (CH_2) groups, but a full discussion of the evidence for this interpretation will be published elsewhere.

We are much indebted to Mr. N. H. E. Ahlers for help in making some of the observations.

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March 29.

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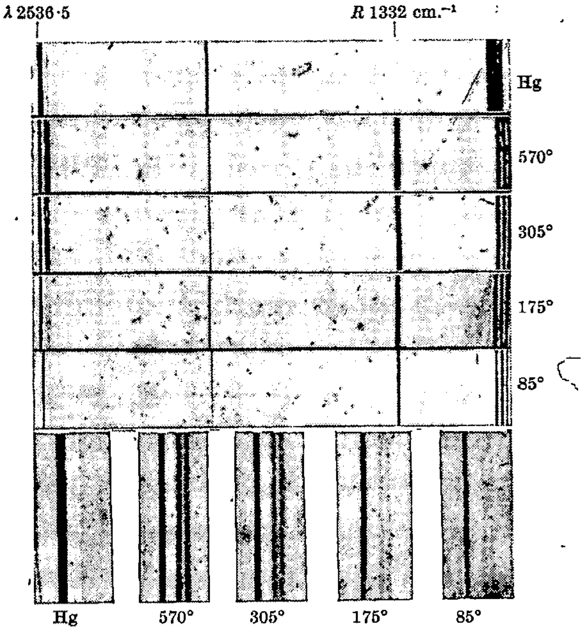
Thermal Scattering of Light in Diamond

RECENT determinations by Bhagavantam and Bhimasenachar[1] of the velocity of sound in diamond show it to be large, about 18,000 metres per sec. for longitudinal waves and about 9,600 metres per sec. for transverse waves along the (111) direction. A simple calculation using these values and the known refractive index of diamond ($\mu = 2 \cdot 61$) shows that the resulting Doppler displacements in the frequency of monochromatic light scattered transversely in diamond should be large enough to be recorded directly without interferometric aid using a quartz spectrograph of moderate power; the separation of the two components shifted in opposite directions would be 16 cm.$^{-1}$ for longitudinal waves and 8 cm.$^{-1}$ for transverse waves. These values refer to the case in which the λ 2536·5 radiation of the mercury arc in quartz is the incident radiation. A special advantage in using this radiation is that parasitic illumination of unaltered wave-length can be quenched by the use of a mercury vapour filter placed in front of the slit of the spectrograph, thereby enabling the Doppler-shifted components in the scattered light from within the crystal to be recorded without any intervening line of unaltered wave-length.



SCATTERING OF LIGHT IN DIAMOND AT DIFFERENT TEMPERATURES

These theoretical expectations are strikingly confirmed in experiment, as shown by the series of spectrograms reproduced herewith; the first of the series represents the incident radiation after quenching by a mercury vapour filter, and the following four are spectrograms of the transversely scattered light with the diamond held at various temperatures. These spectrograms were taken with a Hilger medium quartz spectrograph; the diamond was of the ultra-violet transparent type (No. 174 in Sir C. V. Raman's personal collection). The doubling of the 2536 line in the spectrograms is clearly seen, while in the lower reproduction the same effect is shown on an enlarged scale. It will be noticed from the upper reproduction that in contrast with the strong Raman line having a shift of 1332 cm.$^{-1}$, the intensity of which is practically unaffected by the change of temperature of the diamond, the Doppler-shifted lines become rapidly weaker with falling temperature. This is to be expected on theoretical grounds, since for them $h\nu_s \ll kT$, while for the Raman line $h\nu_r \gg kT$.

I have determined theoretically, with the aid of the recent determinations by Ramachandran[2] of the elasto-optical constants of diamond, the absolute intensity of scattering by the sound waves of thermal origin in diamond. It comes out to be of the same order of magnitude as that actually observed in these experiments, though an exact quantitative test of the theoretical formulæ is as yet lacking. It will be noticed that at all the temperatures actually employed, the Doppler-shifted components are much less intense than the Raman line arising from the principal lattice vibration.

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March 12.

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X-Ray Spectra of Trans-Uranic Elements

In view of the recent discovery of elements with atomic numbers 93–96, it is of interest to recall a calculation based on the assumption of a minimum proper length for the world-line of an electron[1]. The conception that it is impossible to discriminate in space-time between two positions of the electron when the interval separating them is less than h/m_0c (m_0 = rest mass) leads to the result that an electron in a Bohr orbit cannot have a velocity greater than $c/\sqrt{2}$. A further consequence of this is that a K-ring cannot exist in an atom for which $Z > hc/2\sqrt{2}\pi e^2$; and this means that the Bohr–Rutherford model would stop at $Z = 96$. Although the original argument leading to this result cannot be regarded as free from objection in the light of modern quantum theory, the likelihood of some such limitation remains. A more recent application of the principle of minimum length and time to the Rutherford–Bohr atom sets the upper limit to Z somewhat lower than 96 [2].

According to a theory of the structure of the nucleus[3], a limit to Z occurs in the form $Z^2/A < 47{\cdot}8$, a result which suggests that this limit may actually be set by $Z^2/A < hc/4\sqrt{2}\pi e^2 = 48{\cdot}44$. From this, at any rate, it appears likely that nuclei occur with Z values higher than 96, and from what is known of the artificial production of trans-uranic elements it may be anticipated that such nuclei will be produced. Their life, however, may be short owing to the probability of spontaneous fission increasing rapidly with Z^2/A [4].

In view of what has been said above regarding possible anomalies in the K-rings of such atoms, it will be of interest to examine, if possible, the K and L radiations in their X-ray spectra in order to ascertain if the Moseley sequence of X-ray spectral lines shows a break at an element close to 96.

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March 6.

Fisher, J. W., and Flint, H. T., *Proc. Roy. Soc.*, A, **115**, 210 (1927). Flint, H. T., and Richardson, O. W., *Proc. Roy. Soc.*, A, **117**, 637 (1928). Flint, H. T., *Proc. Roy. Soc.*, A, **117**, 630 (1928).

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Bohr, N., and Wheeler, J. A., *Phys. Rev.*, **56**, 426 (1939).

Nature, **159**, 243 (1947).

A New Criterion of Yielding in Metals

Several theoretical criteria of yielding have been proposed[1,2] and tested by comparing the stress values found experimentally just as yielding began under simple stress systems. For example, the ratio of simple shear yield stress to simple tensile yield stress T_0/S_0 is given variously by older theories as 1, 0·77, 0·50, 0·62, while experimentally for common engineering materials this ratio is found to be 0·56 approximately. A better fit to experiment is the theory credited jointly to Huber, von Mises and Hencky (ref. 1, p. 478), which for the above ratio gives $1/\sqrt{3} = 0{\cdot}577$. This theory stated in Hencky's form for the stress system S_{ii}, etc., when $i = 1, 2, 3$, $j = 2, 3, 1$, is

$$\Sigma[(S_{ii} - S_{jj})^2 + 6\,S_{ij}^2] = 2\,S_0^2$$

just as yielding is beginning. If the system of stresses is two-dimensional simple shear together with simple tension, then the Huber criterion gives an ellipse by plotting shear stress as ordinate and simple tension as abscissa. Experimental examination[3,4] shows the experimental values to lie approximately on the theoretical ellipse.

The Huber expression is not convenient analytically because it is not linear in the stresses. I noted this in my theory of post-yield stress-strain[5], but have only recently looked for another criterion that would have a linear form in the stresses. The form that follows came from reasoning that was stimulated by a new theory of large strains[6]. However, in this present communication I will merely show arbitrarily that a linear expression can fit the experimental evidence already quoted.

It is found that $T_0/S_0 = 1/[\sqrt{2}(1+q)] = 0{\cdot}56$ when Poisson's ratio, q, is 0·26, and departs slightly from this value as q varies from metal to metal. This value coincides with the experimental value quoted for common engineering metals.

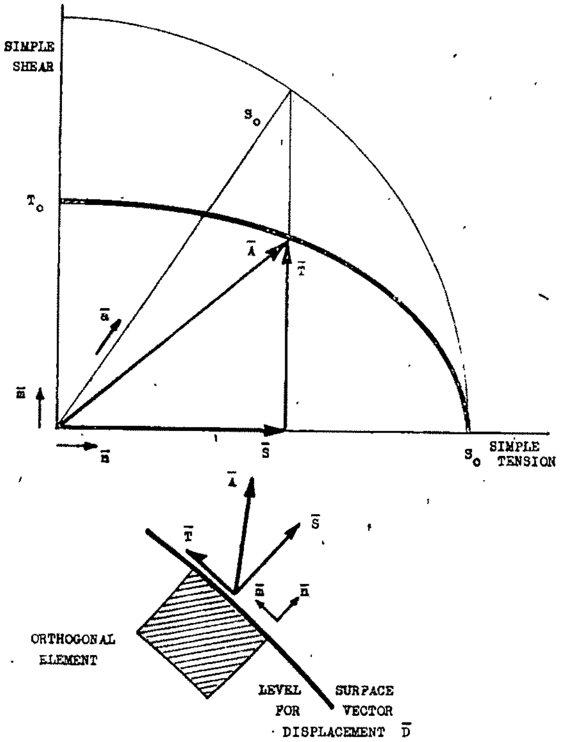
Now consider the ellipse of stress. For any general point stated in terms of the radial vector **a** and the vector stresses **S**, **T**,

$$(\mathbf{T} + \mathbf{S}) = \mathbf{a} \cdot \left[\frac{\mathbf{mm}}{\sqrt{2}(1+q)} + \mathbf{nn}\right] S_0,$$

where the dot indicates the scalar product of the unit vectors **a**, **m**, **n**. This defines the ellipse and reduces to the correct values for S_0, T_0, and hence satisfies the experimental values due to Taylor. Note that in Taylor's tests under simple tension and torsion the level surfaces of vector displacement[3] were planes normal to the longitudinal axis (that is, normal to **n** of the thin tubes used). However, in the general strained body, curved level surfaces of vector displacement are defined. In the simple experimental system or in the more general complex stress systems, the vector $\mathbf{A} = (\mathbf{S} + \mathbf{T})$ is the resultant stress on the face of an orthogonal element with that face in the level surface of vector displacement. In general, the element can be oriented so that **T** has no component normal to the plane of **m** and **n**.

Note that the discussion has been for the simple tensile yield stress S_0, using the first and fourth quadrants of the diagram. Equally well S_0 could be the compression yield, and then one would use the second and third quadrants of the diagram. This may be necessary, for example, with metals having a lower yield stress under compression than they have under tension.

The above linear expression in **S**, **T**, S_0 is suggested as a new criterion of yielding in the general complex



stress case. Such a linear form will allow easier analysis of many particular cases arising from the application of my theory of post-yield stress-strain[5]. In that theory the Huber criterion was used to give the simple tensile stress 'corresponding' to the complex stresses operating at any point in the yielded field. The new linear criterion can be used in the same way.

It is suggested tentatively that the criterion may apply to rupture, in which case S_0 is the simple tensile rupture stress for the metal. Examination of this hypothesis will require the analysis of stresses due to the usually large rupture deformations in some simple cases, and then comparison with the experimental values of the corresponding loads.

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Imperial College of Science and Technology,
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March 8.

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Hiedemann Patterns at Very High Frequencies

Diffraction patterns in liquids have recently been produced in this laboratory by using ultra-sonic waves of frequencies above 100 Mc./sec., and certain interesting features of such patterns have been studied[1]. With a 2-mm. tourmaline plate, frequencies up to 103 Mc./sec. are now communicated to a glass slab as sound waves and the corresponding diffraction patterns obtained by allowing light to pass through the glass slab, as was first done by Hiedemann[2], but at much lower frequencies. The thickness of the glass slab used in our investigations is such that at these frequencies it oscillates at about its 300th harmonic.

Patterns due both to longitudinal and torsional sound waves are obtained either individually or simultaneously. It has been found that by attaching a suitable oscillator plate such as a Y-cut quartz to the glass slab, the longitudinal wave may be suppressed and the torsional wave made prominent and so on. The polarization characters of such diffraction patterns already reported by Hiedemann and others have all been verified. In an earlier communication referred to above, we have reported that the sound wave in water at such high frequencies causes diffraction, which appears to be very much like reflexion in the Bragg sense. In these investigations, also, we have tried the effect of tilting the sound wave-front with reference to the incident light, and found that it introduces a marked asymmetry enhancing the intensity of the diffraction order on the appropriate side, but does not cause it to such an extent as altogether to extinguish the order on the opposite side at small inclinations, as has been found in water. This result is to be expected if we remember that the velocity of sound in glass is nearly four times as great as that in water, making the grating element at such high frequencies in the former four times as large as that in the latter. Consequently, effects due to tilting the sound wave-front obtained in glass at 100 Mc/sec. should be like those obtained in water at 25 Mc./sec. only, which is indeed the case.

The velocities obtained for longitudinal waves of four different frequencies and a torsional wave (46·46 Mc./sec.) in the glass slab are given below:

Frequency, in mc./sec.	13·24	20·74	47·04	103·55	46·46 (*T*)
Velocity, in km./sec.	6·01	6·02	6·02	6·04	3·68

Elastic moduli calculated from the above data are $Y = 8·03 \times 10^{11}$ dynes per sq. cm., $n = 3·34 \times 10^{11}$ dynes per sq. cm., and $\sigma = 0·201$.

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Feb. 28.

[1] [*Nature*, 159, 267 (1947).]

[2] *Naturwiss.*, 23, 705 (1935).

Heat of Atomization of Carbon

In connexion with the series of communications under the above title[1], I wish to direct attention to an old paper which contains an accurate computation of the metastable ^5S state of the carbon atom[2]. The value given in that paper is 4·3 eV. above the ground-state of carbon, and the uncertainty is less than 0·1 eV. This is equivalent to 100 ± 2 kcal./mole.

The method of computation used in that paper is based on quantum mechanical perturbation theory. It differs radically from the usual iso-electronic extrapolation method, because it uses relations between energy states belonging to the same atom and its ions instead of comparing neighbouring atoms. The method gives surprisingly accurate predictions, especially for low levels of high multiplicity. For example, for the similar sp^3 ^5S levels in N II and O III, the computation yields 135 and 173 kcal./mole, whereas the observed values are 133 and 171 kcal./mole.

A comparison with these two examples and with many other cases gives an indication of the size and direction of the error in the computation. The most probable value for the ^5S state of carbon is close to 98 kcal./mole, in good agreement with Edlén's estimate of 94 ± 2 kcal./mole.

S. GOUDSMIT

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March 10.

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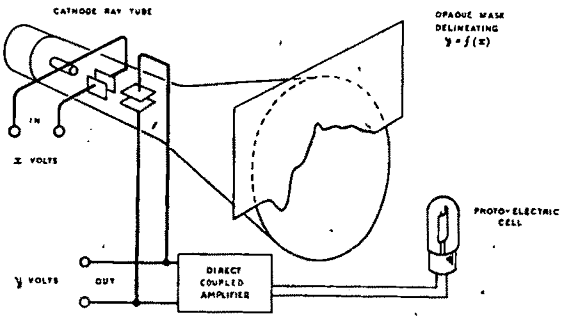
[1] *Nature*, **159**, 129 (1947).

[2] Bacher, R. F., and Goudsmit, S., *Phys. Rev.*, **46**, 948 (1934), see p. 962.

Electronic Function Generator

It is interesting to compare the accompanying diagram with that given by Mr. D. M. MacKay in a recent communication[1]. The present diagram is from the original sketch used in a paper I read to the Rugby Engineering Society on February 6, 1946[2]. This particular embodiment of the idea was demonstrated on the same occasion.



In addition to the applications mentioned by Mr. MacKay, it is possible to combine a pair of electronic function generators to form a high-speed electronic analogue multiplying unit. This aspect has been dealt with in an article which was accepted for publication[3] towards the end of 1946.

A provisional patent application was filed by me and the British Thomson-Houston Co., Ltd., early in 1946[4], and pre-dates the application quoted by Mr. MacKay by some ten months. A complete specification was filed on January 14 this year.

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[1] *Nature*, **159**, 406 (1947).

[2] "Elementary Calculations by Electrical Means".

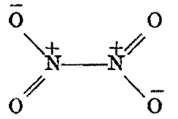
[3] *Electronic Engineering*, in the press.

[4] Brit. Prov. Pat. Spec. No. 3285/46.

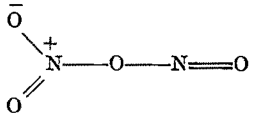
Constitutions of Dinitrogen Tetroxide and Trioxide

THE structure of dinitrogen tetroxide has recently been much discussed, but no clear conclusion has been reached. The structure of dinitrogen trioxide has less often been explicitly considered, but it, too, has remained uncertain.

In general terms, the position with regard to dinitrogen tetroxide has been that, while physical evidence has pointed to structure I, chemical evidence has been held to require some structure, such as II, which is capable of dividing, in addition reactions, to produce a nitroso-group *inter alia*. Structure III has been suggested, but not seriously supported. One proposal for satisfying both the physical and chemical requirements has been to assume forms such as I, II and III in equilibrium[1]. Structure IV represents a very special concept which has been introduced[2] in another attempt to reconcile the physical and chemical indications. (For simplicity, mesomeric states will be represented in each case by a principal valency structure.)



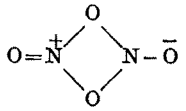
I



II

$O{=}N{-}O{-}O{-}N{=}O$

III

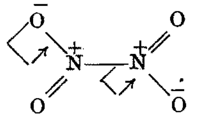


IV

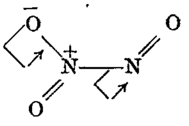
The main point of the chemical evidence has been that, according to the older organic chemical literature, a variety of groups, including nitroso-, nitro-, nitrito- and nitrato-groups, have been introduced into organic compounds by the action of dinitrogen tetroxide[3]. However, this evidence is largely annulled by the recent work of Levy and Scaife[4], from which it is clear that the complicated picture presented by the older literature is the result of an insufficiently exact control of experimental conditions. These authors show that there are but two primary products of the addition of dinitrogen tetroxide to simple olefins, namely, dinitro-compounds and nitro-nitrito-compounds, and that, in the latter products, the nitro-group attaches itself to that carbon atom which carries the larger number of hydrogen atoms. They conclude that, so far as their results are concerned, there is little to choose between formulæ I and II; but we are going to suggest that, considered in a somewhat wider setting, their work completes a chain of evidence leading to a more specific inference.

As regards physical evidence on the structure of dinitrogen tetroxide, some firm conclusions can be drawn from the spectroscopic work of Sutherland[5]. This shows that the molecule possesses a centre of symmetry, and that it has a low, very intense, Raman frequency, such as would arise from a weak central bond. It also excludes the presence, in any large amount, of any tautomer not fulfilling these conditions. This indicates formula I, though it does not clearly exclude either III or IV. (Mesomerism confers an NN-link on IV.) Formula I is also supported by Giauque and Kemp's measurements of the entropy of dinitrogen tetroxide[6]; and Hendricks has shown[7] that the same structure provides a consistent interpretation of Végard's X-ray data[8].

The additive reactivity of dinitrogen tetroxide shows that it is an electrophilic addendum, and adds in the successive parts nitronium ion and nitrite ion. The nitronium ion goes where a proton would in an addition of hydrogen chloride, and it necessarily forms a nitro-group, while the nitrite ion can attach itself to the remaining position either as a nitro- or as a nitrito-group. Either formula I or II can fulfil these conditions, and using formula I the necessary polarization is illustrated in V. We need not consider the question of the free life, if any, of the anionic component of the addendum, since this must depend on the precise conditions of each reaction. Levy and Scaife have found that dinitrogen trioxide adds to simple olefines to form nitro-nitroso-adducts, in which the nitro-group again attaches itself to the carbon atom carrying the greater number of hydrogen atoms. This shows that the trioxide is also an electrophilic addendum, and that it adds in the successive parts nitronium ion and 'monomeric hyponitrite' ion. The structure of dinitrogen trioxide, and its polarization in additions, are therefore as shown in formula VI; and the direction of polarization need cause no surprise, since LeFèvre[9] has pointed out that the tautomeric electron-attraction of the nitroso-group is greater than that of the nitro-group. Formula VI clearly accords with the blue colour of the trioxide, and, since N—N links in general are weak, with its ready dissociability. Finally, taking account of the auto-oxidation of dinitrogen trioxide to dinitrogen tetroxide at − 100°, and of the reduction of the latter by nitric oxide back to the trioxide at − 150° [10], one may conclude that dinitrogen tetroxide is correctly represented by formula V (= I).



V



VI

Thus, having regard to both the physical and chemical evidence, we feel that the long-debated question of the structures of the stable forms of these oxides may be regarded as settled.

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E. Hilda Ingold

Sir William Ramsay and Ralph Forster
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University College, London, W.C.1.
March 28.

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[1] Schaarschmidt, *Z. angew. Chem.*, **31**, 933 (1924).

[2] Longuet-Higgins, *Nature*, **153**, 408 (1944).

[3] Riebsomer, *Chem. Rev.*, **36**, 157 (1945).

[4] *J. Chem. Soc.*, 1093 *et seq.* (1946).

[5] *Proc. Roy. Soc.*, A, **141**, 342 (1933).

[6] *J. Chem. Phys.*, **6**, 40 (1938).

[7] *Z. Phys.*, **70**, 699 (1931).

[8] *Z. Phys.*, **68**, 184 (1931).

[9] *Nature*, **130**, 400 (1932).

[10] Francesconi and Sciacci, *Gaz. Chim. ital.*, **34**, i, 447 (1904).

Retinene$_2$ and Vitamin A$_2$

Retinene$_1$, first noted by Wald in his work on the visual-purple cycle, is the aldehyde of vitamin A [1], from which it has been prepared in high purity[2]. Retinene$_2$, the corresponding aldehyde of vitamin A$_2$, enters into the porphyropsin cycle of freshwater fish retinas. It has been obtained by fractionation of the aldehydes prepared from a mixture of vitamins A$_1$ and A$_2$ derived from ling-cod liver oil[3]. As described by Wald, retinene$_2$ shows $\lambda_{\text{max.}}$ 405 mμ in chloroform and 705 mμ in the antimony trichloride colour test. The preparation obtained by oxidation of vitamin A$_2$ by means of manganese dioxide shows $\lambda_{\text{max.}}$ 405 mμ (chloroform), 385 mμ (cyclohexane), and 720 mμ (antimony trichloride test) fading to 705 mμ.

If vitamin A is oxidized by means of aluminium tertiary butoxide (Oppenauer reaction) using benzene as solvent and diethyl ketone as hydrogen acceptor, a C$_{20}$ aldehyde is obtained[4,5]. This aldehyde cannot be distinguished from retinene$_2$. When fed to vitamin A-deficient rats, it gives rise in the lining of the small intestine and in the liver to a product showing the properties of vitamin A$_2$ ($\lambda\lambda_{\text{max.}}$ 345 mμ, 284 mμ; 693 mμ, antimony trichloride colour test). When retinene$_1$ is similarly treated with aluminium tertiary butoxide, the C$_{20}$ aldehyde is obtained in better yield.

Retinene$_2$, prepared from ling-cod liver oil (that is, from vitamin A$_2$) by oxidation with manganese dioxide, gives a crystalline 2,4-dinitrophenylhydrazone, m.p. 160–161°. The C$_{20}$ aldehyde prepared from vitamin A or retinene$_1$ gives the same compound (no depression in mixed melting point).

These experiments indicate that vitamin A$_2$ differs from vitamin A by one additional conjugated double bond situated in the ring. This agrees with the structure attributed to the C$_{20}$ aldehyde by Heilbron and his colleagues[4]. The aldehyde[6] corresponding in structure with Karrer's alternative formulation for vitamin A$_2$ is very different from retinene$_2$.

R. A. Morton
M. K. Salah
A. L. Stubbs

University of Liverpool.
April 1.

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[1] Morton, R. A., and Goodwin, T. W., *Nature*, **153**, 405 (1944).

[2] Ball, S., Goodwin, T. W., and Morton, R. A., *Biochem. J.*, **40**, *Proc.* lix (1946).

[3] Morton, R. A., Salah, M. K., and Stubbs, A. L., *Biochem. J.*, **40**, *Proc.* lix (1946).

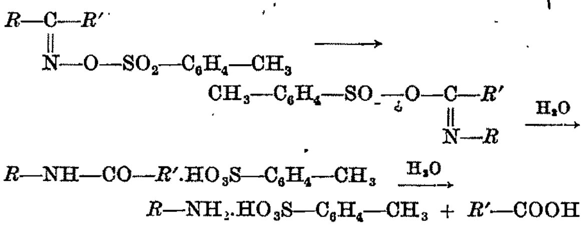
[4] Howarth, E., Heilbron, I. M., Jones, W. E., Morrison, A. L., and Polya, J. B., *J. Chem. Soc.*, **128** (1939).

[5] Hawkins, E. G. E., and Hunter, R. F., *Biochem. J.*, **38**, 34 (1944).

[6] Karrer, P., Geiger, A., and Bretscher, E., *Helv. Chim. Acta*, **24**, 161E (1941).

Conversion of 2-Aceto-furan to Hexen-2-dion-4,5-acetal-1 and Pyrocatechol

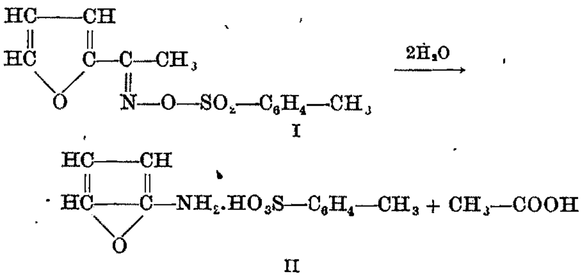
Several workers have already tried unsuccessfully to synthesize 2-amino-furan[1], probably because this compound decomposes very readily. Nevertheless, it was thought that the substance might be produced by a milder procedure. Therefore, we have tried to apply to furan derivatives the reaction discovered by P. W. Neber[2] on *p*-toluenesulphonyl derivatives of certain aromatic ketoximes, according to the following scheme.



$$R\text{—}\underset{\underset{\text{N—O—SO}_2\text{—C}_6\text{H}_4\text{—CH}_3}{\|}}{\text{C}}\text{—}R' \longrightarrow \text{CH}_3\text{—C}_6\text{H}_4\text{—SO}_2\text{—O—}\underset{\underset{\text{N—}R}{\|}}{\text{C}}\text{—}R' \xrightarrow{\text{H}_2\text{O}}$$

$$R\text{—NH—CO—}R'.\text{HO}_3\text{S—C}_6\text{H}_4\text{—CH}_3 \xrightarrow{\text{H}_2\text{O}} R\text{—NH}_2.\text{HO}_3\text{S—C}_6\text{H}_4\text{—CH}_3 + R'\text{—COOH}$$

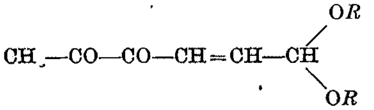
However, on shaking *p*-toluenesulphonyl 2-aceto-furan-oxime (I) with ethanol, not the expected 2-amino-furan or rather its toluenesulphonic acidic salt (II) was formed; but, in addition to toluenesulphonic acidic ammonium, a yellowish-green, strongly



I

II

reducing liquid, free of nitrogen, very sensitive to heat, which can be distilled *in vacuo* at constant temperature, without being decomposed. The analysis and determination of the molecular weight gave the elementary formula $C_{10}H_{18}O_4$ (III). Methanol, instead of ethanol, gives rise to a very similar, though different, substance with the formula $C\,H_{12}O_4$ (IV), showing the same properties as (III). The constitution and configuration of these interesting substances were determined by various methods, and they can be represented by the structural formulæ III and IV:



III

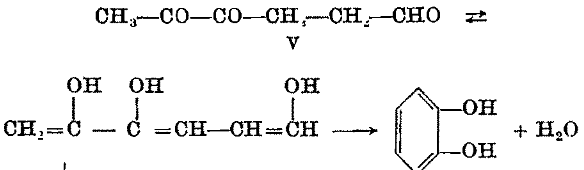
$R = -C_2H_5$. $R = -CH_3$

IV

III and IV are, therefore, to be designated as *cis*-hexen-2-dion-4,5-diethylacetal-1, and dimethylacetal-1, respectively.

In the course of our further work, we endeavoured to study the free aldehydes, corresponding with the acetals III and IV. However, the unsaturated diketo-aldehyde (*cis*-hexen-2-dion-4,5-al-1, CH_3—CO—CO—CH=CH—CHO) could not be produced by hydrolysis of III or IV, because the carbon chain between the carbonyl groups 4 and 5 splits up with formation of acetic acid, even in cold aqueous solution.

The hydrolysis of the saturated acetals (obtained by catalytic hydrogenation of III and IV) also leads to a surprising result; because instead of the expected diketo-aldehyde (hexen-dion-4,5-al-1, V) there was produced pyrocatechol, the formation of which, however, can easily be explained through the enol form VI:



V

VI

Since pyrocatechol and its derivatives are very common in Nature, it is perhaps of interest to show a possible way by which they can eventually be formed from carbohydrates through furan derivatives.

At present no definitive explanation can be given of the mechanism of the conversion of I to III and IV. It is very probable that the reaction does not go according to Neber's formulæ through 2-aminofuran, for by this means the formation of a six-membered carbon chain cannot be explained.

A more detailed description of these investigations will be published elsewhere.

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[1] Leimbach, R., *J. Prac. Chem.*, (ii), 65, 20 (1902). Singleton, H. M., and Edwards, W. R., *J. Amer. Chem. Soc.*, **60**, 540 (1938).

[2] Neber, W. P., *Ann.*, 449, 109 (1926). Neber, W. P., and Huh, G., *Ann.*, 515, 292 (1935).

Kinetics of Polymerization and Molecular Weight Distributions in Polymethyl Methacrylates

RECENTLY, Evans and co-workers[1,2] have examined the polymerization of methyl methacrylate in aqueous solution, when the initiation of polymerization was by hydrogen peroxide in the presence of ferrous ions. The suggested reaction scheme was as follows:

$$\begin{array}{lcl} H_2O_2 + Fe^{++} & \rightarrow & Fe^{+++} + OH + OH^- \\ M + OH & \rightarrow & A_1 \\ A_1 + M & \rightarrow & A_2 \\ A_{r-1} + M & \rightarrow & A_r \\ A_r + A_s & \rightarrow & P_{r+s} \end{array}$$

Algebraic expressions were derived giving the rate of disappearance of monomer and also the distribution of molecular weights in terms of concentrations and the rate constants of individual reaction steps.

Equations appropriate to this reaction scheme arise as special cases of the more general treatment previously given by us[3]. While the kinetic expressions which result from the general treatment are identical with those presented by Evans *et al.*[1,2], the molecular weight distribution function is obtained in a different form. In this note it is suggested that the equations for molecular weight distribution derived from the more general treatment[3] possess certain advantages over those proposed by Evans.

Adopting the same symbols as in the papers by Evans, and substituting in the appropriate distribution function for termination by combination which is given at the bottom of page 497 of ref. 3, there results the following equation:

$$P_r = \frac{a_0^3\beta^3}{2M_0^2}\, r \int_{M/M_0}^{1} \gamma^{3(\beta-1)} \exp\left(\frac{-a_0\beta}{M_0}\gamma^{\beta-1} r\right) d\gamma \qquad (1)$$

Equation (1) should be compared with the equation (17) presented by Evans *et al.*, which may be written as

$$P_r = \frac{a_0^3\beta^3}{2M_0^2}\,(r-2) \int_{M/M_0}^{1} \gamma^{3(\beta-1)} \left[1 + \frac{a_0\beta}{M_0}\gamma^{\beta-1}\right]^{-r} d\gamma \qquad (2)$$

Equation (1) can be written as

$$P_r = A_0 u^{-p}\,[I(u,p) - I(u(M/M_0)^{\beta-1}, p)] \qquad (3)$$

where $A_0 = \frac{1}{2} a_0\beta \left(\frac{a_0\beta}{M_0}\right)^{p+2} \left(\frac{\beta-1}{3\beta-2}\right)^{p/2} \Gamma(p+1)$;

$$p = \frac{2\beta-1}{\beta-1}; \quad u = \frac{a_0\beta}{M_0}\sqrt{\frac{\beta-1}{3\beta-2}} \cdot r;$$

$$I(u,p) = \frac{1}{\Gamma(p+1)} \int_0^{u\sqrt{p+1}} e^{-v} v^p dv.$$

The function $I(u,p)$ is the incomplete gamma function which has been tabulated over an extended range of the values of u and p by Pearson[4], so that the laborious graphical integration required by equation (2) can be avoided.

Moreover, inspection of equation (3) shows that if β is constant (that is, p is constant) and if M/M_0 (the fraction unconverted) is constant, then P_r can be expressed solely as a function of u provided A_0 (which is a function of M_0 and a_0) be suitably adjusted. Therefore, it follows that it is unnecessary to calculate P_r separately for different values of a_0, M_0 (when β and M/M_0 are constant), since the curves of P_r against r or rP_r against r can all be derived from a single one by a suitable multiplication of the scale of the r and P_r co-ordinates.

It is not possible to derive any simple expression for the value of r at which the maximum occurs in the rP_r against r curve, but it is possible to derive such a relationship for the occurrence of a maximum in the $r^{(2\beta - 1)/(\beta - 1)} P_r$ against r curve by simple differentiation. The maximum occurs at

$$r = \frac{M_0}{a_0\beta} \; \frac{3\beta - 2}{(M/M_0)^{\beta - 1} - 1} \ln (M/M_0). \quad (4)$$

Comparison of the calculated value of r from equation (4) with that derived from the experimental values of Evans gives $9 \cdot 2 \times 10^3$ calculated compared with 10×10^3 experimental. The agreement is rather better than the fit of the experimental and calculated curves from equation (3) as measured by the maximum in the rP_r against r curve, which occurs at $4 \cdot 5 \times 10^3$ (experimental) and at $3 \cdot 0 \times 10^3$ (calculated).

Thus it can be seen that by adopting the earlier general treatment, not only can the integration be expressed in terms of the well-tabulated incomplete gamma function, but also the variation of distribution with concentration of monomer and initiator can readily be derived. Further, this approach enables an additional test between theory and experiment to be made.

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National Animal Breeding
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Hendon, Middlesex.

[1] Baxendale, Evans and Kilham, *Trans. Farad. Soc.*, **42**, 668 (1946).

[2] Baxendale, Bywater and Evans, *Trans. Farad. Soc.*, **42**, 675 (1946).

[3] Herington and Robertson, *Trans. Farad. Soc.*, **38**, 490 (1942).

[4] Pearson, "Tables of the Incomplete Gamma Function" (H.M. Stationery Office, 1922).

Ionic Exchange and Fibre Contraction

A $0 \cdot 2\,N$ aqueous solution of sodium alginate (molecular weight $\sim 10^5$) was extruded into $1\,N$ hydrochloric acid, thus producing alginic acid fibres, which were converted into calcium alginate by immersion in $M/10$ calcium acetate. The well-washed calcium alginate threads, fully swollen with water, contained $0 \cdot 37 \times 10^{-3}$ gm.-equiv. calcium per gm., the ratio of equivalent calcium to equivalent water-insoluble acid was 1·0, and the dry weight was about 8 per cent. These fibres were opaque, slightly elastic, birefringent and capable of heterogeneous cation exchange reactions in which a replacement of the calcium by other cations takes place.

During the study of this ion exchange under continuous flow conditions[1], it was observed that on replacement of the calcium by sodium or potassium a striking change of shape of the fibres takes place. An experiment of this kind was as follows. A calcium alginate thread, fully swollen with water, and 0·4 mm. in diameter, was hung over a hook and rinsed with $1\,N$ sodium carbonate, at a rate of flow of 2·0 cm.³/sec. During this treatment an initial contraction of the fibre, followed by a lengthening, took place, as shown below :

Time from start of flow (sec.)	0	5	10	20	30	40	50	60
Length of fibre (cm.)	14·0	13·4	13·0	12·6	12·2	12·5	13·3	14·6
Contraction (%)	0	4·5	7	10	13	11	5·5	−5

After 60 sec., the experiment was interrupted in order to weigh the fibre ; there was an increase of weight of about 20 per cent. In a control experiment, analyses were carried out after 30 sec., when the maximum contraction had occurred, and it was found that 29 per cent of the calcium had been converted into calcium carbonate, with simultaneous formation of sodium alginate. In estimating the calcium carbonate formed in this double decomposition, the fibre was immersed in water, and carbon dioxide was bubbled through the suspension ; the calcium carbonate was thus quantitatively converted into the soluble calcium bicarbonate, while the undecomposed calcium salts were treated with $1\,N$ hydrochloric acid, the calcium thus liberated being separately determined.

A similar shortening of various alginate fibres is also brought about by solutions of alkali phosphates, fluorides, oxalates or citrates. In some of these experiments, the contraction was as large as 20 per cent of the original fibre-length, and the weight of the fibre did not change during the shortening. The birefringence of the fibre decreased during the contraction, while the elasticity and the transparency increased. A few preliminary tests were also done under isometric conditions, when a force of at least 3 gm./mm.² was observed.

In attempting to explain these effects, it is assumed that the bivalent calcium ions form salt bridges between adjacent alginate chains, thereby building up a three-dimensional network in which the chains formed by repeating *d*-mannuronic acid residues must be relatively straight. On replacing some of the calcium by alkali ions, gel segments will be liberated, which are more flexible than the completely 'vulcanized' structure. The segments will be able, therefore, to take up configurations which are statistically more probable and in which the chains are curled up to a certain extent ; this will lead to a shortening of the fibre as a whole. The results obtained with other alginate fibres can be explained along similar lines, but it is not always possible to specify the nature of the inter-molecular cross-links.

In general, the contraction is regarded as a partial gel-sol transition, an interpretation which is also in accordance with the observed change of birefringence, transparency and elasticity. An important condition for fibre contraction appears to be that the replacement of calcium by alkali ions occurs rapidly. A number of experiments, to be described elsewhere, indicate that on slow replacement of the calcium by alkali ions no appreciable contraction of the fibres occurred, which is probably due to a predominating influence of plastic flow. The latter effect is perhaps mainly responsible for the lengthening of the fibres after contraction, but other reactions may also play a part during this stage of the ionic adsorption.

This investigation is being continued and extended to the study of protein and nucleoprotein fibres.

We are grateful to Prof. A. V. Hill for his interest in this work and to the Department of Scientific and Industrial Research for financial assistance.

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March 25.

[1] This technique is similar in principle to that used in chromatographic adsorption analysis, and has also been used for an investigation of the cation exchange properties of the Brown Algæ from which the sodium alginate is extracted. See Wassermann, paper submitted to *Proc. Roy. Soc.*

Stability of Penicillin in Aqueous Solutions

WORK conducted in 1945 in the research laboratories of the Admiralty, but not then published, suggested that partially purified penicillin (calcium) from surface culture was more stable than the crystalline material. In addition, it was not found that phosphate, when included in penicillin solutions, produced any definite increase in the stability of the antibiotic.

The experiments were primarily carried out to obtain some information on the effect of solutions of different hydrogen ion concentrations on typical commercial samples of calcium penicillin as then being distributed at a potency of 362 units/mgm. Only when this work was under way did any information appear on the stability of penicillin solutions to various acidities. This work[1], however, applied to the crystalline sodium penicillin from submerged culture and stated that the pure material was more stable than the partially purified penicillin.

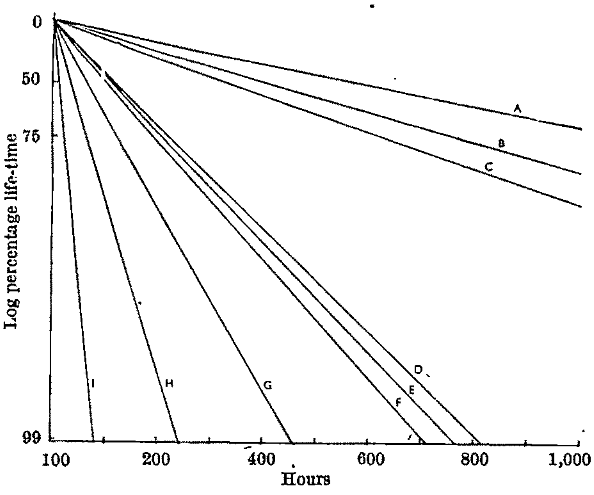
In the present work the stability of calcium penicillin was determined at each *p*H value from 2·00 to 10·0 in buffer solutions, these latter comprising:

*p*H 2·00 potassium chloride—hydrochloric acid.
3·00 potassium hydrogen phthalate and hydrochloric acid.
4·10, 5·00, 6·00 } potassium hydrogen phthalate—sodium hydroxide.
6·00, 7·00 } potassium dihydrogen phosphate—sodium hydroxide.
8·00, 9·00, 10·00 } boric acid—sodium hydroxide.

These were selected experimentally, and found to be most suitable for the work, in preliminary experiments in which the temperatures were only approximately maintained at the specified levels. All buffer solutions were checked immediately prior to use against a standard buffer solution of known value on a meter.

The experiments at 4° C. were conducted in the refrigerator as this provides the usual storage place; those at 27·7° C. and 37·4° C. being thermostatically controlled in water baths.

Two samples of the sterile dried calcium salt were dissolved in separate bottles of the required buffer solution at the specified temperature, the final concentration being 500 units/ml. One bottle was utilized for removal of samples for assay, the second being used to determine the variation, if any, of the *p*H during the experiment. Samples were removed from the first bottle into ice-cold buffer mixture so that the final *p*H was about 6·5, at which the sample was stable for assay. The assays were carried out by the absorptiometer method in addition to the cylinder plate process, both employing *S. aureus* as the test organism. The *p*H and sterility of both bottles were determined at the conclusion of the experiment.



A, *p*H 5, 4° C.; *B*, *p*H 7, 27° C.; *C*, *p*H 6, 27° C.
D, *p*H 7, 37° C.; *E*, *p*H 4, 4° C.; *F*, *p*H 6, 37° C.
G, *p*H 5, 27° C.; *H*, *p*H 8, 27° C.; *I*, *p*H 3, 4° C.
Graphs for other values have been obtained similarly.

Results. Concentrations of penicillin were plotted against time for each of the temperatures and *p*H values. From the graphs the life-times of the antibiotic were expressed as percentages of the initial concentration.

LIFE-TIME OF PENICILLIN IN HOURS

Temperature	4° C.		27·7° C.		37·4° C.	
	99%	50%	90%	50%	99%	50%
*p*H 2·00	14·4	2·15	1·24	0·2		
3·00	78·55	11·83	6·36	0·95		
4·10	773·0	114·0	72·0	11·0		
5·00		562·0	462·0	70·0		
6·00				334·0	712·0	107·0
7·00				402·0	820·0	126·0
8·00			241·0	36·0	74·6	11·3
9·00			64·7	9·7		
10·00			14·6	2·2		

Omissions indicate that no experiments were carried out at the particular temperature, or alternatively, at *p*H 5, 6, 7, the samples proved so stable that the experiments were discontinued after obtaining the 50 per cent life-times.

These life-times are shown in the accompanying table, which indicates the 50 per cent and 99 per cent life-times of calcium penicillin at the various *p*H values and temperatures. The figures illustrate the more rapid inactivation of the drug in alkaline than in acid solution in the range tested.

Penicillin proved so stable at *p*H 5·00–7·00 that no accurate experimental results were attempted for 99 per cent life-time of penicillin at *p*H 5·0 and 4° C. Likewise at *p*H 6·0 and 7·0 at 4° C. and 27·7° C.

In contrast to other workers it was found here that penicillin was more stable at *p*H 7·00 than 6·00, but whether this is due to an increased stabilizing effect of phosphate at the higher *p*H only is not certain. This higher stability at *p*H 7·00 is clearly shown at both temperatures. Furthermore, the pure sodium penicillin appeared to be less stable by direct comparison with partially purified penicillin (calcium) at 24·3° C., and also by indirect tests at 27·7° C. At *p*H values of 3, 4, 5, 9, 10, where temperatures of 27·7° C. and 37·4° C. only were employed, even indirect comparisons with the pure material of other workers were not legitimate due to the length of time occupied by the life-times of penicillin.

At *p*H 6·0 and 7·0 (both 27·7° C. and 37·4° C.), however, the calcium penicillin used here proved more stable than the pure sodium salt is stated to be at 24° C. and 37° C. Possibly the impurities act catalytically, being more active in alkaline than in acid solution and perhaps also being inert or 'stabilizers' in neutral solution.

Summarizing, it may be stated that the partially purified penicillin employed here is more stable in solution than the crystalline material is believed to be. That this increased stability is not due to the different type of salt used seems evident from the extensive work on penicillin salt stability published elsewhere[2].

In reference to the phosphate effect on stability, it may be noted that none of the buffer solutions had any deleterious action on penicillin. At *p*H 6·0 and 7·0, phosphate buffer solutions were employed, and a recent communication[3] suggests that some stabilization had been effected by these ions. Whether this was so may be judged from experiments carried out here at *p*H 6·0 using both a phosphate and a non-phosphate buffer solution for this acidity. In only one instance out of five did any slight increase in the life-time appear with the phosphate buffer as compared with the other solution. This, however, may have been due to an effect similar to that described recently[4], which stated that although remarkable success followed stabilization of sodium penicillin with phosphate, it was impossible to produce similar satisfactory results with calcium penicillin solutions.

I should like to express my gratitude to Surgeon-Captain Mussen, R.N., for permission to publish this work.

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[1] Coghill, R. D., *J. Bact.*, **49**, 85 (1945); **51**, 291 (1946).

[2] Randall, W. M., *J. Amer. Pharm. Assoc.*, **15**, 7 (1945).

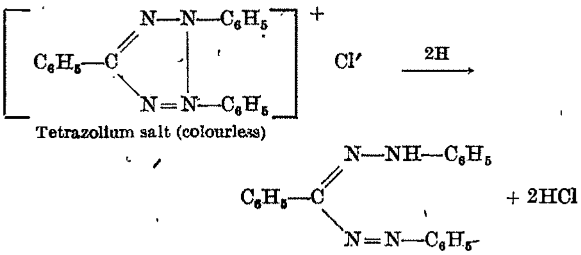
[3] Pulvertaft, R. J. U., *Nature*, **156**, 82 (1945).

[4] Pratt, R., *Nature*, **159**, 233 (1947).

Tetrazolium Salt as a Seed Germination Indicator

A TOPOGRAPHICAL chemical test for germination was devised by Lakon[1] using sodium biselenite, which, on account of its toxicity, he rejected in favour of the tetrazolium salts[2]. Later, he evolved a technique for maize[3] with 2,3,5-triphenyl tetrazolium chloride, which was used in Germany during the War[4]. As information about other cereals was inadequate, a preliminary assessment of this compound as a germination indicator has now been made.

This tetrazolium salt is colourless, non-toxic, water-soluble, and easily reduced by either chemical or phytochemical means[5] to the triphenylformazan, an insoluble red dye.



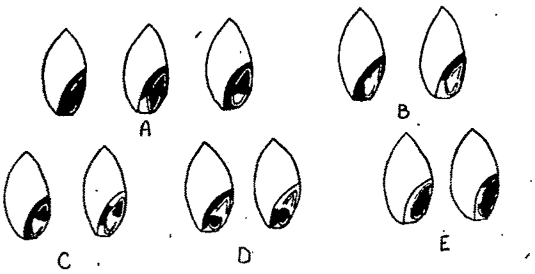
Tetrazolium salt (colourless)

Formazan (red)

When treated with an aqueous solution, the living tissues of germinating seeds are stained red; the conditions of the test being so arranged that the chemical processes of germination have already begun. In cereal seeds the whole of the embryo becomes stained, leaving the endosperm unaffected; whereas dicotyledonous seeds are stained completely.

The seeds are soaked in tap water overnight (18 hr.). Then they are cut through longitudinally in order to bisect the embryo. One half only of each seed is placed in a Petri dish (7 cm.), which just holds 100 grains or vetches, or 25 peas. Tetrazolium salt solution (1 per cent) is poured over them until every seed is just covered, and they are allowed to soak in the dark at 20° C. for 4 hr. The viable seeds have by now become stained, so the solution is poured off and the seeds, after washing with water, are examined individually.

In cereals other than maize, ability to germinate normally is indicated by staining of at least one half of the scutellum, the whole of the shoot part, and the transition part between root and shoot where the adventitious roots arise. The accompanying diagram indicates the types of staining encountered; only those in *A* are capable of normal germination. The same technique has been applied to peas and vetches.



STAINING REGIONS IN CEREAL SEEDS

A few typical results are set out in the accompanying table and compared with results obtained by the standard laboratory method.

COMPARISON OF TETRAZOLIUM AND GERMINATION TESTS

Seed	% Seeds capable of normal germination	
	Tetrazolium test	Standard germination test
Oats	85	88
Barley	97	98
Wheat (*a*)	99	99
(*b*)	39	40
Peas	97	97
Vetches	70	66

In the tetrazolium test, results are obtained within 24 hours as compared with ten days or more for the standard laboratory germination test. At the same time, latent causes of abnormality can be observed without any specialized botanical knowledge or skill, or elaborate apparatus. The method is more exacting and time-consuming for the individual worker, but against this must be set the advantage of obtaining a speedy evaluation of seed viability, either as a final or merely as a screening test.

A fuller account of this work will be published elsewhere.

I would like to express gratitude to Mr. C. C. Brett of the Official Seed Testing Station for his advice, and to the directors of May and Baker, Ltd., for permission to publish this communication.

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[1] Lakon, G., *Ber. deut. bot. Ges.*, **57**, 191 (1939).

[2] Lakon, G., *Ber. deut. bot. Ges.*, **60**, 299 (1942).

[3] Lakon, G., *Ber. deut. bot. Ges.*, **60**, 434 (1942).

[4] C.I.O.S. Report, Item 24, No. XXVI-73.

[5] Kuhn and Jerchel, *Ber. deut. chem. Ges.*, **74B**, 941.

New Aspects of the Action of Methylthiouracil

G. MANSFELD demonstrated[1] that in the serum of overheated animals a substance, thermothyrine A, is present which, injected into normal animals, decreases oxygen consumption. Serum of thyroidectomized animals has no effect.

I have shown[2] that thyroidectomized guinea pigs react to high environmental temperature by a more rapid, higher and prolonged hyperthermia than normal animals. This effect is not due to lack of thyroxine, because thyroxine enhances the effect of thyroidectomy on this reaction. Therefore, lack of thermothyrine A must be assumed as an explanation.

The fact that in later experiments similar results were obtained in animals treated with methylthiouracil raised the question whether methylthiouracil not only inhibits the formation of thyroxine but also the production of thermothyrine.

Dogs and rabbits were treated daily with 0·10 gm. per kgm. methylthiouracil for four weeks, and were then subjected for five hours to a temperature of 34–35° C., which raised their body temperature by 0·5–1·5° C. 2·5 c.c. of serum obtained at the end of the 5-hour period failed to reduce oxygen consumption of normal rats, while sera of untreated dogs and rabbits produced after similar exposure to high temperature a fall of oxygen consumption by 14–48 per cent. It is therefore evident that methylthiouracil inhibits the formation of both thyroxine and thermothyrine A.

The fact that thermothyrine A contains no iodine[3] proves conclusively that the action of thiouracil compounds cannot be exclusively an inhibition of iodinization.

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University of Pécs.
Feb. 28.

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[1] Mansfeld, G., "Die Hormone der Schilddrüse und ihre Wirkungen" (B. Schwabe and Co., Basel, 1943).

[2] Berde, B., *Experientia*, 2, 498 (1946).

[3] Mansfeld, A., *Nature*, 157, 491 (1946); and *Schweiz. Med. Wschr.* (1946).

A Rapid Supra-vital Staining Method for Assessing the Viability of Human Spermatozoa

We have developed a 4-minute technique for the supra-vital staining of spermatozoa which facilitates the estimation of viability and at the same time is suitable for the examination and counting of abnormal forms.

The method is based on the principle of Emmens[1] for rabbit spermatozoa which, however, is unsuitable for human material.

Method : Supra-vital stain, 50 c.c. distilled water; 1 gm. Revector Soluble Blue 706; 1·5 gm. glucose; 0·1 gm. sodium chloride; 0·3 gm. disodium hydrogen phosphate, hydrated; 0·005 gm. potassium dihydrogen phosphate, anhydrous. (This solution must be made up freshly; or alternatively it may be stored in 1 ml. ampoules and autoclaved.)

Counterstain : 1 per cent neutral red in distilled water.

Fixative : Half-volume saturated solution of mercuric chloride in distilled water; half-volume absolute alcohol; followed by 90 per cent alcohol containing a few drops of iodine in potassium iodide to give straw-coloured solution.

Four or five drops of seminal fluid are placed on a clean slide or in a small tube, and one drop of the supra-vital stain is added and well mixed. The mixture is left for 2–3 min. and one drop is withdrawn and a thin smear is made on a clean dry slide. The smear is allowed to dry in air, and is then fixed in the above fixative for 15–20 sec.; the slide is then dipped into alcoholic iodine, and into 90 per cent alcohol, and allowed to dry. The counter-staining is effected by putting the slide into neutral red for 15–30 sec., rinsing in water and differentiating *with care* in 90 per cent alcohol. The smear may then be dried and examined directly under oil immersion, or it may be passed through absolute alcohol and xylol and mounted in Canada balsam.

The nuclei of the spermatozoa which were dead when the seminal fluid was mixed with the stain are blue or purple; those that were alive are *clear* red, and a few non-nucleated forms remain unstained.

The stain does not kill living spermatozoa, since the motility of spermatozoa mixed with the soluble blue–Baker's fluid solution is unaffected. We have found motile spermatozoa in the stain after a period of 36 hours. The decrease in motility of sperm in the stain solution is of the same order as that of sperm in its own seminal fluid.

A. C. Crooke
Anita M. Mandl

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April 3.

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[1] *J. Physiol.* In the press.

Two Symbiotes of *Psylla mali*

As a representative of Psyllid I selected *Psylla mali*, which, feeding on the apple tree, was easily available for investigation, and also for confirmatory work by other investigators. Profft[1] has published the best account that has appeared on symbiosis in this group of insects. On p. 312, in Fig. 19, he illustrates a section of the bacteriotome, called by him, in conformity with others, a mycetome. Unfortunately, the magnification of the section is only 165, which is exceptionally low for any cytological study. Further, he does not give any illustration of the symbiotes as seen in a smear of the tumour. In his illustration the majority of the tumour cells contain curved dark-staining objects. When I studied them in smears, stained with Giemsa, they appeared to be thick comma-shaped bacteria.

Profft's illustration, Fig. 19, also shows some tissue cells faintly stained, with contents very indistinct. These tumour cells contain very delicate and short bacteria which are best seen in smears stained with Giemsa.

A medium with apple juice was used for cultivating the symbiotic bacteria. The thick comma type of bacterium produced a bright green pigment like the colour of the insect. Morphologically, the tissue smear and that from the bacterial growth were identical. I noticed a cherry tree accidentally infected with *Psylla mali*; the insect which is usually green was now brownish-red. I made another medium with cherry extract. The medium was faintly coloured dirty pink. On plating, the comma-shaped symbiote of *P. mali* produced a bright cherry colour, like the colour of the insect feeding on the cherry tree. The share of the bacterium in producing a pigment derived from the food was thus evident.

The minor symbiote, the delicate bacterium, did not produce any pigment, and its role in the economy of the insect was not discovered.

This work was done some years ago, at Berlin, in the laboratory of Prof. F. F. Nord, now at Fordham University, New York. It is a pleasant duty to acknowledge his interest again here.

S. Mahdihassan

Research Institute,
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Hyderabad.
March 5.

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[1] *Z. Morph. u. Okol.*, 32, 312 (1937).

APPLIED BIOLOGY IN THE LEATHER INDUSTRY

THAT the leather industry forms an extensive field for research in applied chemistry has been well known for many years; that it forms a field, at least as extensive, for research in applied biology has been less well appreciated; and this notwithstanding the facts that the raw material of the industry is animal skin, that oils used by the industry and many tanning agents are plant products, that bacteria and moulds play havoc with certain of the processes of manufacture, and that insects cause damage to stored hides and finished leather. Clearly, in such an industry there must be opportunities for research in animal histology and physiology, as well as in microbiology, entomology and biochemistry; and some account of the problems presented in these various fields was given in a symposium held on March 21 at the Imperial College of Science and Technology by the Association of Applied Biologists in conjunction with the British Leather Manufacturers' Research Association.

The symposium was introduced by Sir Robert Pickard, who outlined the elaborate processes of leather manufacture, laying emphasis on the biological aspects and remarking that the problems of the industry call for co-operation between the statistician, the chemist, the physicist, the biologist and the psychologist, and directed attention to the fact that the tanner is handicapped by his raw material, the animal skin, over which he has very little control, as it is a by-product of other industries.

Discussing the factors that affect the animal skin, Mr. J. N. Turner stated that until comparatively recently the quality of skins received by the tanner did not vary greatly, and production of leather resolved itself into a relatively simple routine; but nowadays, with a wider market of supply and with advances in breeding and feeding techniques, many of which favour the milk- or meat-producing qualities of an animal at the expense of the leather-making properties of its skin, very wide variations are liable to occur that may necessitate certain changes in manufacture and in the resulting product. An acquaintance with recent trends in agricultural genetics and animal husbandry is therefore important to a modern leather manufacturer. It is only within the last decade that any attempt has been made to ascertain and measure the effects on the skin of cross-breeding and intensive feeding: for example, South African work has shown the effect of breed variations on the wearing quality of sole leather from cattle hides, and other work has indicated the effect of intensity of feed upon the fat content of hide and its bearing on grease stains in the finished leather. Differences in skin may also result from variations in climate and topography, and artificial changes may be induced by sex hormones, silicic acid or by compounds that stimulate mitosis.

Collagen, or white fibrous tissue, is the chief component of the animal skin from the leather industry's point of view. To the collagen fibres are due the properties of a leather, such as its tensile strength and resistance to abrasion; and much time has been devoted to the study of collagen by histologists and biochemists. In presenting some problems associated with reticulin, elastin and collagen in the skin, Miss M. Dempsey and Miss M. E. Garrod said that elastin and reticulin possess an importance out of all proportion to their amount. For reticulin fibrils that bind the collagen fibres together have a restrictive effect upon the swelling of collagen during the wide *p*H variations of the tannery processes; and elastin, which occurs in the skin chiefly in both the papillary and the innermost layers, has a particular effect on that outer part of the skin that eventually becomes the 'grain' layer of the leather. One of the difficulties in their investigations was to isolate pure samples of the fibres from the animal skin; consequently work was done, for example, on reticulin from adipose tissue, elastin from ligamentum nuchæ, and on collagen from rat-tail tendon, the binding sheath of which consists of both elastin and reticulin. They are not certain, however, that findings on these easily accessible tissues are directly applicable to similar tissues in the skin.

That the study of the surface chemistry of the animal skin is of importance and interest to the industry was indicated by Dr. K. G. A. Pankhurst. The conversion of animal skin to leather involves the three main constituents of the skin: protein, lipoid and water. The globular proteins are largely removed, the fibrous proteins are chemically modified by tanning, the natural lipoids are usually removed at an early stage of the process and are replaced by others at the end, and the water content is considerably reduced. Dr. Pankhurst pointed out that the three phases allow of six possible interfaces: protein–lipoid, protein–water, protein–air, lipoid–water, lipoid–air, protein–air; and each presents peculiar problems to the tanner. Leather is composed of an interlacing network of fibres that creates a system of *quasi* capillaries; consequently, as it is always necessary to have a full control over the kind of liquid that flows through them, a knowledge of the chemistry and physics of the flow of liquids is important in many leather-making problems. The penetration of a liquid into a fibrous structure is dependent on (*a*) the adhesion between fibre and liquid, (*b*) the surface tension of the liquid, and (*c*) the size and spacing of the fibres in the surface. The effective angle of contact that the liquid makes with the skin is an index of the penetrability of the liquid into it: if the angle is 90° or less the liquid will flow through; if it is greater than 90° the liquid will not flow through unless a certain pressure is applied to it. Penetration problems arise in the soaking of dried skins, the removal of lipoids from wet skins, the re-introduction of lipoids after tanning, waterproofing, etc.

One of the more curious processes in leather manufacture is that of 'bating'. It is a pretanning process in which tryptic enzymes are allowed to act on the skin. When it is properly done a characteristic silky smoothness is produced in the finished leather. From the earliest days of the industry, bating has been done with the dung of certain animals; but in more recent times the use of these unpleasant materials has been largely replaced by the appropriate enzymes. In dealing with the use of enzymes in the industry, Dr. E. W. Merry confined his attention to the bating process. The enzymes are obtained chiefly from pig pancreas, but ox pancreas, fish viscera, bacteria and fungi are also used. It has been shown that a preparation of pure chymotrypsin from pancreas can produce a typical bated effect in a skin. However, the mixed proteolytic enzymes in a bate have various effects on the different skin proteins: it appears that they affect, to greater or lesser degrees, elastin, collagen, keratin and perhaps reticulin, and it has been suggested that they have an important effect on the erector pili muscles in the skin. It seems not unlikely that, in the future, bates may be made up with specified enzymes, so that the different proteins of the skin may be preferentially attacked according to the class of leather desired.

Bacteria are notorious in the industry as the cause of putrefaction and, in the form of anthrax, as a danger to operatives. In their paper on this aspect, Dr. M. E. Robertson and Miss B. M. Haines said that putrefaction is usually prevented either by drying the hides after flaying or by treating them with sodium chloride as a preservative. The treatment of hides with a salt of marine origin, however, is likely to encourage a growth of red halophilic bacteria, known to tanners as 'red heat'; but this can be prevented by the addition of sodium fluoride to the salt. The use of disinfectants is also recommended in the process known as soaking, during which bacterial damage is especially common. The important process of liming kills all active stages of bacteria, but some spores (including those of anthrax) can survive; these can be killed by 'drumming' in lime and sodium sulphide at a raised temperature. Bacteria can, however, sometimes be of use to the industry: in America, bacteria producing lactic acid are used to promote the necessary acidity in the tan liquors, but in Great Britain the method is regarded as too difficult to control.

During many of the stages from skin to finished leather, mould fungi occur: except as a source of bating enzymes, they are a nuisance. The industry has also its insect pests, the chief being, perhaps, the beetles of the genus *Dermestes*. Mr. A. J. Musgrave, dealing with mycological and entomological problems, outlined the damage caused by fungi in the various processes. It is well known that vegetable-tanned leather is a better substrate for fungal growth than that which has been chrome-tanned; but the kind of processing a leather has received affects its liability to mould growth; moreover, there is need for a fuller acquaintance with the species of fungi that occur in the industry, and of the damage that they cause. A number of fungicides are available to the industry, which has wisely made use of available knowledge; and there are various ways in which fungicides can be incorporated in leather, though its multifarious uses make every proofing problem worthy of individual attention.

A considerable number of insects associated with the industry has been recorded. The chief pests seem to be warble flies, attacking the living skin, *Dermestes* beetles on dried hides, clothes-moths and carpet beetles on furs, and various insects attacking leather in the tropics. In addition, the fly *Piophila casei* is a considerable nuisance. It appears that the most systematic efforts at control have been those directed against *Dermestes* beetles: for many years arsenication of dried hides has been practised. The difficulties encountered in carrying out laboratory tests on insecticides and fungicides for the industry were discussed: some simple preliminary experiments have indicated that 'Gammexane' may be more toxic than D.D.T. to *Dermestes maculatus*.

Finally, when the leather has been manufactured, it may be found to be faulty in some way, or a tanner may realize during manufacture that there is some irregularity. A method in leather biology that is indispensable in investigating these faults and in controlling the various processes is a specialized branch of animal histology: the study of the fibre structure of skins and leather. In dealing with this subject, Miss M. Dempsey stipulated that it is the task of the student of fibre structure to attempt to correlate what he sees with the physical properties of the leather and with the kind of processing it has undergone. The condition of the collagen fibre bundles and their manner of interweaving constitutes, *sensu strictu*, the fibre structure of the leather: the history of a leather is written in the appearance of its fibre bundles. The properties of a leather, she said, are dependent on its fibre structure, the appearance of which not only gives information about the suitability of a process, but also indicates the quality of the leather, and, more important still, may reveal the cause of a flaw, such, for example, as skin disease or putrefaction, chemical breakdown during manufacture or maltreatment in use. The various features of fibre structure were described and their practical importance indicated.

A fuller account of this meeting is to be published in the *Annals of Applied Biology*.

RESEARCH AND INDUSTRY IN SCOTLAND

THE Scottish Regional Conference on "Research and the Progress of Industry in Scotland" arranged by the Federation of British Industries and held at the Merchants' Hall, Glasgow, on April 25, was on similar lines to that of the Midlands Regional Conference of the Federation at Birmingham in March. A message from Sir Edward Appleton wishing the Conference success contained, however, perhaps the most important statement made there. After indicating that the Department of Scientific and Industrial Research had been giving a good deal of attention to the question of the diffusion of scientific knowledge, and was looking to these conferences for guidance as to how best to deploy the limited scientific effort of Great Britain, Sir Edward said that to improve the Department's contacts with Scottish industry it is arranging to open a Scottish branch of the recently created Intelligence Division; and he cordially invited firms to discuss their special problems with the Department when that branch had been opened.

The morning session of the Conference considered the established industries of the region, Mr. W. Barr dealing with research in the steel industry, followed by Sir Wilfred Ayre on research in the shipbuilding industry and Mr. W. G. Marshall on research in the heavy engineering industries. Mr. Barr referred particularly to the recruitment of workers with technical knowledge in order that the results of research may be utilized. Steelmaking, so long practised as an art, is slowly becoming a science founded on the laws of physical chemistry, but much remains to be done before the desirable degree of control throughout the process is attained. Sir Wilfred Ayre, pointing out that the Scottish industry should not be differentiated from the larger British shipbuilding industry of which it is a part, suggested that the application of science in the industry would be facilitated if firms were readier to present the results of their research either in papers before technical institutions or to the industry's research association. He referred particularly to the valuable contribution of the various technical institutions, as well as to the work of the classification societies, and to the important part which the technical colleges might take in research. Private firms, however, must continue increasingly to carry out scientific work for themselves, and increasing numbers of their technical staff will require a more scientific training; and he stressed the need for planning so as to ensure that research work is at all times adequately prosecuted undisturbed by fluctuations in the prosperity of the industry. Commenting on the special problems of Scottish heavy industry, Mr. Marshall emphasized its comparative isolation from other industrial areas, the lack of variety of technical facilities, and of the skilled man-power and brain-power provided by light industry. It is thus the more important that the industry should make the fullest use of existing technical facilities. After reviewing the functions of an industrial research department, including the necessity of keeping abreast of research and development work elsewhere, and the qualifications of its staff, he briefly outlined the problems with which the research department of Messrs. Babcock and Wilcox, Ltd., is concerned. No section is entirely devoted either to routine or to research, and physics is of increasing importance in almost every branch of technology.

At the afternoon session, which considered broadly the balancing of Scotland's industries, Dr. J. W. McDavid reviewed the experience of the Explosives Division of Imperial Chemical Industries, Ltd., with nitrocellulose finishes, 'Cellofas', ethylcellulose, pentaerythritol, 'Ardil', etc., to indicate the way in which a live research and development department leads to new manufactures loosely but logically connected with the main industry. Dr. W. M. Cummings' paper, "Chemical Research for Scottish Industry", considered especially the needs of the small manufacturer who is characteristic of the region. The region is not big enough industrially to have several different research organisations, and while Dr. Cummings referred to the idea of establishing a research organisation in Scotland, working in close association with the Department of Scientific and Industrial Research, covering all branches of industry, engineering, building, coal, food, etc., he appeared to look rather to the technical colleges for greater assistance, and in particular he commended the example of the Joint Research Council established in Manchester. The idea could be extended with advantage in other areas, and should promote the contacts between industry and the technical colleges and universities which are all-important.

Mr. J. N. Toothill, discussing "Research in the Light Engineering Industries", commented on the effect of research and development on export policy and its assistance in securing balanced employment. It also helps to raise the standard of living of the community, and it can be an important factor in determining the location of industry. Mr. Toothill dealt with this idea in some detail, suggesting that in a new light industry, the growth of new products arising out of technical discoveries and appreciation of their market possibilities, and communications with market centres and centres of research, are more important influences on the location of industry than the supply of cheap raw material, adequate modern factory facilities and adequate, cheap and reliable supplies of electric power. At present, Scotland employs only 2·5 per cent of the total scientific man-power of the United Kingdom, as against a working population of 10 per cent, and new industries fail to grow in all areas distant from London. In this connexion, he referred to the tendency in the United States, and to some extent in Great Britain, to segregate the direction of policy, market research and technical research in areas near the national headquarters, leaving production to be carried out where labour is available.

In the final paper of the Conference, Prof. R. Hay, reviewing the individual Scottish firm and its application of research, pointed out that the first essential is a desire on the part of firms to utilize the advances already made in technical research. For small firms he suggested first the engagement of a professional consultant. For larger firms a technical development officer might be employed as technical adviser to the head of the firm, working in conjunction with established research associations, possibly supplemented by a small staff of his own. To meet the dearth of qualified men a co-operative effort of technical colleges and industry would be required, while finally Prof. Hay urged that industry in Scotland could with advantage develop a research centre on the lines of the Mellon Institute.

EMISSION OF RADIO-WAVES BY THE GALAXY AND THE SUN

By JOSEPH S. SHKLOVSKY

Sternberg Astronomical Institute of the Moscow State University

THE remarkable investigations of Reber[1], Southworth[2] and Appleton[3] have shown that radio-waves in the metre and centimetre region are emitted by the galaxy and the sun. Henyey's and Keenan's theory of long-wave emission by the galaxy[4] is based on the assumption that the mechanism of this emission is a free-free emission from interstellar gas. However, they have not correctly accounted for the absorption of radio-waves in the galaxy. Besides free-free absorption (which Henyey and Keenan took into account), there is an ordinary absorption of radio-waves because of damping oscillations of electrons in the field of radio-waves. The coefficient of absorption is given by

$$\alpha_\nu = \frac{\pi e^2 N_e}{m} \cdot \frac{1}{c} \frac{\gamma}{4\pi\nu^2 + (\gamma/2)^2}.$$

In interstellar space (and even more so in the solar atmosphere) the constant of damping γ is determined by the collision of electrons with ions. In this case

$$\gamma = 4N_i\sqrt{\frac{2\pi k T_\varepsilon}{m}} \cdot \frac{\pi}{2} \frac{e^4}{(kT_\varepsilon)^2} \ln \left(\frac{3}{2} \frac{kT_\varepsilon}{e^2 N_\varepsilon{}^{1/3}}\right),$$

where $N_i = N_e$, the concentration of ions, and T_ε is the electron temperature.

Solving the equation of transfer, we get the following expression for the intensity of galactic radio-emission :

$$I_\nu = \frac{2\nu^2 k T_\varepsilon}{c^2} (1 - e^{-\tau_\nu}),$$

where τ_ν is the optical depth of the galaxy in a given direction. Here the coefficient of absorption is accounted for in the above-mentioned manner.

Each intensity of a given optical depth of the galaxy in a given direction measured by Reber can be brought to a mutual correspondence. Assuming that $T_\varepsilon = 10{,}000°$, we find that the above-mentioned τ_ν changes from 0·48 (in Sagittarius, where the intensity is the highest) to 0·008 (in Perseus). For most regions of the Milky Way τ_ν is less than 0·1

Eddington and, in more detail, Strømgren showed[5] that interstellar hydrogen is ionized in the so-called zones of ionized hydrogen which surround the hot stars. According to Strømgren, the ratio of the volume of the zones of ionized and unionized hydrogen is 1/9. In the zones of ionized hydrogen N_e is[6] of the order of 2–4/cm.^{3}; in the zones of unionized hydrogen N_e is at least a hundred times smaller. Therefore, the zones of unionized hydrogen practically do not have any influence on the long-wave emission of the galaxy, as their optical depth is negligibly small. If the above-mentioned estimation of the ratio of both zones were correct, τ_ν would be much larger in all directions in the galaxy than those determined by Reber.

It can be supposed that the volume of the zones of ionized hydrogen given by Strømgren is too large. Strømgren extrapolated the relative number of hot stars observed in the vicinity of the sun to the whole galaxy. However, according to Baade[7], hot stars belong to the so-called 'first type' of population of the galaxies and are found only on the borders of the latter.

The optical depth of the solar atmosphere for radio-waves of different wave-length can be calculated. The optical depth of the chromosphere for $\lambda = 1$ cm. is 3×10^3; for $\lambda = 10$ cm., it is 3×10^5; and for $\lambda = 187$ cm., it is 10^8. Therefore, the chromosphere is not transparent for radio-waves. The optical depth of the corona for the same wave-lengths is correspondingly $1\cdot2 \times 10^{-4}$, 0·013 and 4·5, assuming that the electron temperature of the whole corona $T_e = 350{,}000^\circ$[8]. Therefore, the radiation in the centimetre range observed by Southworth is emitted mainly by the top layers of the chromosphere, that of the metre region (Reber) by the corona. However, if the temperature of the electrons of the whole corona were equal to 350,000°, the radio emission would be at least one hundred times larger than that measured by Reber. In order to bring theory and observations into accordance, it is necessary to assume that the electron temperature of the outer corona is relatively low and equal to about 3,500°. In this case the optical depth of the outer corona ($R/R_\odot > 3$) will be equal to 4·6. The outer corona will absorb intensely the radio emission of the 'hot' inner corona; its own emission will correspond to low temperature.

Recently Appleton[3] ascertained that at times the sun emits radiation $7 \text{ m.} < \lambda < 30$ m., the intensity of which is at least 10^4 times more than the intensity of a black body at $T = 6{,}000^\circ$. He connects this with bright eruptions in the solar atmosphere. This phenomena evidently could not take place if the emitter were a black body.

We suppose that in this case the proper vibrations of the plasma of the outer corona are the cause of radiation. This is based on the astonishing coincidence of the frequency of proper vibrations of the plasma given by Langmuir's formula:

$$\omega_L = \sqrt{\frac{4\pi e^2 N_e}{m}}$$

with that observed by Appleton's fellow-workers. Linder[9] showed that it was possible for longitudinal waves to be propagated in the plasma with a frequency close to ω_L. Every vibrating electron will emit radiation of frequency ω_L. This phenomena was observed by Penning[10], Ditmer[11] and others.

Proper vibrations of plasma may be caused by a flow of charged corpuscles, which move through the corona with a velocity more than that of sound. This was observed experimentally by Merill and Webb[12]; Vlasov[13] worked out a theory explaining the loss of energy of charged particles through their exciting proper vibrations. If the concentration of fast corpuscles necessary for exciting vibrations of the observed power is calculated, taking this theory as a basis, the derived values are fully reasonable.

If the proposed theory is correct, there must be a magnetic storm about one day after the outburst of the anomalous radio emission. After the above was written, I learned that this had been observed[14]. Another result of this theory is that the sun should emit, to a great extent, radiations in the decimetre range caused by proper vibrations of the plasma of protuberances and upper chromosphere. The corona only slightly absorbs this radiation. The 'decimetre' and 'metre' radiations should arise almost simultaneously. Entirely new possibilities for predicting geophysical phenomena are therefore revealed.

Details of this investigation are given in the *Russian Astronomical Journal*, **23**, No. 6, 333.

[1] *Astrophys. J.*, **100**, 279 (1944).
[2] *J. Franklin Inst.*, **239**, 285 (1945).
[3] *Nature*, **156**, 635 (1945).
[4] *Astrophys. J.*, **91**, 625 (1940).
[5] *Astrophys. J.*, **89**, 526 (1939).
[6] *Astrophys. J.*, **88**, 364 (1939); **89**, 119 (1939).
[7] *Astrophys. J.*, **100**, 137 (1944).
[8] *Z. Astrophys.*, **3**, 199 (1933).
[9] *Phys. Rev.*, **49**, 753 (1936).
[10] *Physica*, **6**, 241 (1926).
[11] *Phys. Rev.*, **28**, 507 (1926).
[12] *Phys. Rev.*, **55**, 1191 (1939).
[13] *Sci. Letters Moscow State Univ.*, **75** (1945).
[14] *Nature*, **157**, 46, 48 (1946).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 2

UNIVERSITY COLLEGE, LONDON (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. R. O. Kapp: "The Presentation of Technical Information" (other lectures will be given on June 9, 16 and 23).*

Tuesday, June 3

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Rev. W. J. Culshaw: "The Santals of Western Bengal".

Wednesday, June 4

PHYSICAL SOCIETY, COLOUR GROUP (at the Lighting Service Bureau, E.L.M.A., 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. H. G. W. Harding: "The Colour Temperature of Light Sources".

INSTITUTE OF PETROLEUM (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. R. P. Russell: Second Cadman Memorial Lecture.

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. Magnus Pyke: "Nutrition in Post-War Germany and Austria" (members of the Food Group are invited).

Thursday, June 5

FEDERATION OF BRITISH INDUSTRIES (at the Royal Victoria Hotel, Sheffield), at 10 a.m.—Regional Conference on "Industry and Research".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Thomas Merton, F.R.S.: "On Interference Microscopy"; Dr. S. Tolansky and Mr. W. L. Wilcock: "Interference Studies of Diamond Faces—A Crossed Fringe Technique".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, June 6

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, at the Torquay Natural History Museum, Babbacombe Road, Torquay), at 10 a.m.—Discussion on "The Microbiological Aspects of Food Quality" (to be opened by Prof. H. D. Kay, F.R.S.). (Meeting will constitute the Food and Nutrition Section of the Health Congress.)

INSTITUTION OF THE RUBBER INDUSTRY (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 5.30 p.m.—Dr. Philip Schidrowitz: "The Impact of Synthesis on the Rubber Industry" (Second Foundation Lecture).

Chemical Society, Hull Local Section (joint meeting with the University College Scientific Society, in the Assembly Hall, University College, Hull), at 6.15 p.m.—Sir Ian Heilbron, F.R.S.: "Some Aspects of the Chemistry of Penicillin" (Inaugural Lecture).

Tuesday, June 3—Friday, June 6

Institute of Fuel (at the Royal Hall, Harrogate).—Conference on "Pulverised Fuel".

Tuesday, June 3

At 10.30 a.m.—Opening of the Conference; at 2.30 p.m.—First Session.

Wednesday, June 4

At 10 a.m.—Second Session; at 2.30 p.m.—Third Session.

Thursday, June 5

At 9.30 a.m.—Fourth Session.

Friday, June 6

At 10 a.m.—Fifth Session; at 2.30 p.m.—Closing Session.

Institute of Welding (at King's College, Newcastle-upon-Tyne).—North-East Coast Meeting. Visits and Technical Papers.

Saturday, June 7

Biochemical Society (in the Medical School, Hospitals Centre, Birmingham), at 1.30 p.m.—Scientific Papers.

Sunday, June 8

Institute of Economic Engineering (at the Waldorf Hotel, Aldwych, London, W.C.2), at 2.30 p.m.—Mr. E. H. Lewis: "Factors Affecting Output per Man-Hour".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Senior Assistant in Metallurgy in the Bradford Technical College—The Director of Education, Town Hall, Bradford (June 7).

Lecturer (temporary) in Zoology—The Secretary, University of Durham, 38 North Bailey, Durham (June 7).

Lecturer in Civil Engineering, a Lecturer in Mathematics, a Lecturer in Physics, a Lecturer in Chemistry, a Lecturer in Biology, and a Lecturer in Electrical Engineering, at the Brighton Technical College—The Education Officer, Education Office, 54 Old Steine, Brighton 1 (June 7).

Junior Physicist to take part in the clinical, teaching and research work of the Physics Department, and a Physicist to assist in research on application of physics to medicine—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London S.W.3 (June 9).

Lecturer in Mathematics—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (June 9).

Principal Scientific Officer at the Royal Observatory, Blackford Hill, Edinburgh—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1916 (June 10).

Assistant Registrar—The Secretary, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 13).

Provincial Specialist Advisory Officers, Assistant Advisory Officers, and District Advisory Officers, in the National Agricultural Advisory Service—The Secretary, Ministry of Agriculture and Fisheries, 4 Bickenhall Mansions, London, W.1, endorsed 'N.A.A.S.' (June 14).

May and Baker Research Fellowship in the Department of Physical Sciences—The Registrar, Wye College, Wye, Ashford, Kent (June 14).

Lecturer in Biology, and a Lecturer in Chemistry—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (June 14).

Chemist to take charge of the Plant Protective Chemistry Section—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (June 14).

Lecturer in Applied Mathematics—The Registrar, King's College, Newcastle-upon-Tyne (June 14).

Assistant Psychologist in the Research Unit of the Civil Service Commission—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1890 (June 14).

Demonstrator in Chemical Pathology—The Registrar, The University, Leeds 2 (June 15).

Grisedale Scholarship for Research in Botany or Zoology—The Registrar, The University, Manchester (June 20).

Assistant Physicist in the Radiotherapy Department—The House Governor, London Hospital, Whitechapel, London, E.1 (June 20).

Assistant Lecturers in Physics and Geology, Research Demonstrators (part-time) in Physics and Chemistry, and an Assistant Lecturer in Mathematics—The Registrar, University College, Singleton Park, Swansea June 21).

Lecturer in Geology, a Lecturer in Physiology, and a Demonstrator in Geology—The Secretary, Queen's University, Belfast (June 21).

Assistant Keeper in Egyptology in the Manchester Museum—The Registrar, The University, Manchester 13 (June 21).

Lecturer in Physical Chemistry—The Registrar, The University, Reading (June 23).

Lecturer in Physics—The Registrar, The University, Manchester 13 (June 28).

Agriculturist, and a Plant Breeder, in the Department of Agriculture, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (June 30).

Assistant Lecturer in Geology—The Registrar, The University, Reading (June 30).

Principal Research Officer in the Engineering Division of the National Building Research Institute—The Secretary-Treasurer, Council for Scientific and Industrial Research, Private Bag 189, Pretoria, South Africa (June 30).

Botanist—The Director, Imperial Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge (June 30).

Director of Sugar Technological Research at Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (June 30).

McRobert Research Fellow to undertake research relating to any disease that is generally regarded as malignant or incurable in Bacteriology, Biology, Chemistry, Chemotherapy, Clinical Science, Pathology or Physics—The Secretary, The University, Aberdeen (June 30).

Lecturer in Civil Engineering, and a Lecturer in Mechanical Engineering—The Director, Robert Gordon's Technical College, Aberdeen (June 30).

Chair of Anatomy at Charing Cross Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 1).

Senior Lecturer, a Lecturer or Assistant Lecturer, and an Assistant Lecturer or Demonstrator, in the Department of Glass Technology—The Registrar, The University, Sheffield (July 1).

Professor of Botany, a Professor of Zoology, and a Professor of Civil Engineering, in the University of Ceylon—The Secretary, Inter-University Council, 8 Park Street, London, W.1 (July 1).

Shell Studentship in Geophysics—Dr. E. C. Bullard, Department of Geodesy and Geophysics, Cambridge (July 1).

Chair of Public Administration at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 3).

Chair of Theoretical Physics—The Registrar, The University, Liverpool (July 7).

Forest Officers (5) in the Forestry Division of the Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, Rhodesia House, 429 Strand, London, W.C.2 (July 12).

Lecturers in Physics, Botany, Zoology, Geology, and Assistant Lecturers in Mathematics, Physics, Chemistry, Botany, Geology, Geography, Engineering—The Registrar, University College, Nottingham.

Physicist (male or female) to the X-Ray Therapy and Radium Centre, St. Luke's Hospital, Guildford—The County Medical Officer, County Hall, Kingston-on-Thames.

Physical Chemist (male) for fundamental research on high-temperature reactions involving iron and other elements—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Physicist (mainly in connexion with radium and X-ray therapy)—The Secretary, Samaritan Free Hospital for Women, Marylebone Road, London, N.W.1.

Technician in the Museum and Histological Departments—The House Governor, Hospital for Sick Children, Great Ormond Street, London, W.C.1.

Lecturer in Pharmacy—The Secretary, Royal Technical College, Glasgow.

Laboratory Technician (Grade C) in the Physiology Department—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W.C.1.

Secretary—The Director of Research, British Baking Industries Research Association, Wellington House, 125–130 Strand, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Journal of Glaciology. Vol. 1, No. 1, January. Pp. 42. (London: British Glaciological Society, c/o Royal Geographical Society, 1947.) 7*s.* 6*d.* [81

Educational and General Interest Films, Sound and Silent. Pp. 80 + 12 plates. (London: G.B. Instructional, Ltd., 1947.) 2*s.* 6*d.* [81

Ministry of Health. Nurses Salaries Committee: Mental Nurses Sub-Committee. Further Recommendations. Mental Nurses S.C. Notes, No. 8. Pp. 10. (London: H.M. Stationery Office, 1946.) 2*d.* net. [81

Current Affairs, No. 19: The Future and the Atom Bomb. By Peter Wright. Pp. 20. (London: Bureau of Current Affairs, 1946.) 7*d.* [81

Atomic Survey: a Short Guide to the Scientific and Political Problems of Atomic Energy. Pp. 32. (Birmingham: Atomic Scientists' Association, Sec., Prof. P. B. Moon, The University, 1946.) [91

Other Countries

Memoirs and Observations of the Czechoslovak Astronomical Society. No. 7: A Hypothesis on the Origin of the Solar System and that of Multiple Stars. By Dr. Jan Šourek. Pp. 17. (Prague: Czechoslovak Astronomical Society, 1946.) [3012

Yale University School of Medicine. Sixth Annual Report of the Historical Library, 30 June 1946. Pp. 34. (New Haven, Conn.: Yale University, 1946.) [3012

Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation. Twenty-third Annual Report, 1946. Pp. 4. (Boston, Mass.: Dr. J. C. Aub, Sec., Massachusetts General Hospital, 1946.) [3012

State of California; Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 64: The Biology of the Soupfin, *Galeorhinus zyopterus*, and Biochemical Studies of the Liver. Pp. 96. (Terminal Island, Calif.: California State Fisheries Laboratory, 1946.) [81

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UNIVERSITY PLANNING IN GREAT BRITAIN

IN replying to the debate on the development of the universities in the House of Lords on May 14, the Lord Chancellor said little that added to what is already known regarding the plans and intentions of the Government. Nevertheless, in referring to the comparisons which are continually being made about the size of the university population in Great Britain and other countries, he did well to emphasize that such comparisons can be misleading "unless one realizes exactly what is meant by university education". The real meaning of that extraordinary American figure of one in 125 going to a university is rarely understood. In expressing his belief that there is a strong case for following the Americans "in having whole-time education up to university age", Lord Lindsay of Birker categorically declared that "many of the institutions to which these American undergraduates go we should not consider universities". Discussing the problems raised by the existence of these institutions, Dr. R. M. Hutchins, chancellor of the University of Chicago, wrote recently in *The Observer* : "The United States has led the way in providing education for all the people, and this provision is certainly a milestone on the march along what is called the Democratic Way of Life. In fact, however, this provision is both too little and too much. It is too little because it rests on the assumption that if no or low fees are charged education is free. It is too much because it is indiscriminate."

It was not, however, for purely academic reasons that the Lord Chancellor resisted the plea of Lord Lindsay of Birker that an independent Government Committee should be appointed to review university policy. The refrain of his speech was that the powers of the University Grants Committee have been so extended that it is now able "to assist, in consultation with the universities and other bodies concerned, the preparation and execution of such plans for the development of the universities as may from time to time be required in order to ensure that they are fully adequate to national needs" ; and that, since there is no immediate likelihood of the latest estimates of the needs of the universities prepared by the University Grants Committee being met, nothing is to be gained by the appointment of another committee. "The real trouble," said the Lord Chancellor, "is the building problem" ; and, as this is no short-term problem, the outlook is indeed gloomy. The University Grants Committee estimates that the developments which the universities are willing to undertake in the next five years will require £50,000,000, four-fifths of which is for the erection and equipping of new buildings. While the Chancellor of the Exchequer has accepted that estimate and expressed his willingness to find the money, the Minister of Works does not believe that, even if university building is given a high priority, more than £20,000,000 of building will be possible in this period. The most that he is prepared to promise is that he is willing to review the position from year to year.

This emphasis which the Lord Chancellor chose to place on the building problem has had the unfortunate effect of obscuring the larger and more fundamental questions which Lord Lindsay of Birker raised in opening the debate. Are we quite sure that the present framework of university education should be merely perpetuated ? Is there not room for further experiment ? Is there a place for institutions like the *Écoles des Sciences Politiques* or *des Études Polytechniques* of France, or the great German *Handelshochschule* ? Are the schools providing enough boys and girls of the right type to permit a doubling of numbers in the universities without a lowering of standards ? Is there any assurance of a demand for their services once they have passed through the universities ? These are, in the view of Lord Lindsay of Birker, some of the questions which require investigation ; and it is scarcely surprising that he should ask whether a committee the business of which it is year by year to consider grants to the universities is "the best committee to look at the whole set-up, with the idea, perhaps, of some revolutionary change".

One difficulty in charging the University Grants Committee with the responsibility of making policy decisions is what *The Economist* has called its "passive acceptance" of the suggestions offered by the universities and the Committee of Vice-Chancellors and Principals. "It could never," says *The Economist*, "compel London University to break itself up against its will ; neither is it prepared to go against the advice of the Vice-Chancellor's Committee that it is better to concentrate resources in the existing institutions than to dissipate limited reserves of personnel and materials on entirely new ones." Although it has given favourable consideration to the proposed experiment at Stoke-on-Trent, the wording of the resolution which has been communicated to the sponsors of the scheme deserves to be noted : "That the committee would consider sympathetically an application for financial assistance in respect of a new university college in North Staffordshire, provided that the basis of studies in science and art be adequately broadened". And again : "If this scheme is to include the conferment of degrees by the college, the committee will wish to be satisfied that adequate arrangements have been made for sponsorship by a university or universities". In short, although the promoters of the scheme drafted it in the belief that "a local university college should have a close relation to the distinctive characteristics of the locality it serves", the University Grants Committee has, in effect, replied that there must be more evidence of conformity to the *status quo*. In making this request the Committee may be wise ; but, if *The Economist* is right in its assertions, it is not easy to believe that the proposals have been subjected to impartial and independent examination.

Even more difficult—and certainly not less pressing—is the problem of the co-ordination of the work of the universities and technical colleges ; and its speedy solution would seem impossible without the creation of such a committee as Lord Lindsay of Birker requested. Indeed, it might well be argued that the full and satisfactory implementation of the findings of the Percy Committee on Higher Technological Education will otherwise prove impracticable. While that Committee did recommend the selection of a strictly limited number of technical colleges in which there should be developed technological courses of a standard comparable with that of university courses, Lord Eustace Percy alone suggested that the Government should adopt the policy of developing certain colleges into major university institutions. It may be true, as the Lord Chancellor hinted, that, "if the recommendations of the Percy Committee for a National Council of Technology are implemented (as there is every reason to think they may be), it would be one of the functions of that council to consider whether such a policy of up-grading is feasible, and if so, how it could best be carried out" ; but what guarantee at present exists that the status of university institutions would not be denied to those colleges which were up-graded unless "the basis of studies in science and art be adequately broadened" ?

Yet another aspect of this problem of the need for a body specifically charged with the task of co-ordinating policy was noted by Dr. Eric James, high master of Manchester Grammar School, at the conference on "The Place of Universities in the Community" arranged by the British Association and held at the University of Manchester on May 10. As already noted in *Nature* (of May 24), Dr. James urged that the work of the Barlow Committee is incomplete because no evidence was taken from schools as to their capacity to provide the requisite number of potential science graduates. In assuming that there is a waste of intelligence and talent, he may be right ; and, if he is, there is a pressing need to discover at what stage of education the wastage occurs. On the other hand, Lord Lindsay of Birker does not share this view. In discussing the extension of secondary education under the Education Act, he remarked : "As anyone concerned with education—particularly secondary education—is aware, the problem which arises from this reform is : Can we combine a high standard of English secondary education with a great increase in numbers—a threefold increase in numbers ? . . . I do not believe we could, for one moment, have multiplied the pupils going to grammar schools without affecting the standard of the grammar schools."

Important as this question undoubtedly is, it is even more important to know the real requirements of the nation for different kinds of scientific, technical, professional and managerial skill. Although certain professional bodies have made their own estimates—the Ministry of Education for teachers and the Goodenough Committee for medical men—neither the Barlow Committee nor the Hankey Committee tried to break up the whole requirements into detailed specialities. More recently, the Urwick Committee, in its report on "Education for Management" (H.M. Stationery Office. 6*d*.), has failed lamentably to find answers to the vital questions—the numbers engaged in management, the future demand for managers, and the experience of training for management gained in other countries. Without some clear indication of the national need for physicists, chemists, metallurgists, statisticians, economists or managers it is impossible for the universities to know whether they are over-expanding or under-expanding particular departments. It may, for example, be the sheerest folly to insist that "the basis of studies in science and art be adequately broadened", and that the traditional balance of studies should continue to be maintained. The answer to these questions will not be found until some body has the primary responsibility of co-ordinating and expanding the findings of existing reports and of presenting a comprehensive picture of the needs and opportunities in the field of higher education.

Least of all should it be forgotten that the task of university education is not to transmit an established body of knowledge. The university must do infinitely more than teach facts and theories. It must help the student to develop his faculties; it must train him to think independently that he may form his own judgments; and it must teach him methods of study that will enable him to keep pace with developments. In the medieval *disputatio* professor and students discussed a subject, weighing the pros and cons of an argument. While that form of teaching has its modern counterpart, the expansion of scientific teaching has resulted in new forms of academic instruction unknown to the medieval university. These methods are as applicable to the social as to the natural sciences. Political science divorced from field work in parliaments and government offices cannot be taught efficiently. Economics is a dead subject if the student has no opportunity to watch the process of production and distribution in mines, factories, shops, and the stock exchange; and if sociology is to be more than the philosophy of history it requires still more extensive field work. These principles are accepted in theory. How far they are being applied is still another question that requires to be answered.

TRIUMPHS OF THE BIRD PHOTOGRAPHER

Masterpieces of Bird Photography

Edited by Eric Hosking and Harold Lowes. Pp. 144 (63 plates). (London: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s*. 6*d*. net.

HAD this book been published in 1939 I believe we should have seen a higher standard of reproduction of the various outstanding photographs of birds which render it a remarkable volume. But the difficulties of post-war production are not the only ones which cropped up—some of the negatives of the earlier photographers have been irretrievably lost, and reproduction had to be made from existing prints. That fine photograph, for example, of the pair of golden eagles at the eyrie together, taken by the late A. J. Rooker Roberts, would, I am sure, have been much better reproduced had the negative been found. The book is largely the work of members of the Zoological Photographic Club, to which the volume is dedicated. The birds shown are all British birds, although some of them have been photographed abroad. The reproduction of the snow goose, for example, was taken in Greenland by the late David Haig-Thomas, and William Farren's spoonbill was secured in the Marismas of Andalusia.

As is perhaps unavoidable, the standard of the photographs is uneven; some are without distinction, but a considerable number are good and some of them are excellent. To my mind, for sheer beauty and artistic perfection, the photograph of the kittiwake on the wing, taken by John Barlee, is supreme.

Some of the photographs reproduced are historic. We are shown, for example, what is the first ornithological photograph taken—that of a song thrush's nest by the late Cherry Kearton, exposed on April 11, 1892—fifty-five years ago. Here, too, is reproduced the first photograph ever taken of a bird on the nest—the bird is a lapwing, and was photographed by the late R. B. Lodge in 1895, by remote control, for 'hides' had not then been invented. All of us who are bird photographers are in the debt of that grand pioneer in Nature photography, the late Richard Kearton, who did more than any man to encourage a love for birds. Some of his photographs are still outstanding; but many of his best negatives have been lost, otherwise a more striking one than that here reproduced—a bullfinch on the nest—might have been chosen. Curiously enough, I was the means of that picture being taken. The bullfinch was nesting in our garden in Aberdeenshire and was so tame that she sometimes rose from the nest to take hemp seed held between my lips. I was a boy at the time (the date of the photograph, by the way, is earlier than that mentioned, 1908) and had telegraphed Kearton to come and photograph a ptarmigan's nest which I had found. One of Kearton's legs, on account of a fall from a tree, was six inches shorter than the other, and few persons with that handicap would have climbed to a height of more than 3,000 feet. The climb took us all night, and Kearton carried his heavy camera on his shoulder, on its stand all ready for use.

The Kearton brothers—Richard and Cherry—were the first to see the possibilities of a 'hide' for bird photography, and experimented with one made of the skin of an ox stretched over a hollow frame.

Perhaps the most interesting photograph in the book, from a historic point of view, is that taken by the late Cherry Kearton of a pair of ospreys at their tree eyrie on Loch Arkaig, one of the last British nesting haunts of this beautiful bird, now lost to us through the inroads of the man with the gun and the egg collector.

Most of those whose photographs illustrate this book are members of the Zoological Photographic Club: one misses the work of certain well-known photographers, such as R. M. Lockley, who has taken some remarkable shearwater photographs.

Most of the photographs are of birds at the nest, but on page 49 there is a striking picture, which it must have taken great patience to obtain, of a mixed party of knot, curlew, oyster-catcher and bar-tailed godwit at the edge of the tide. It is a really remarkable photograph, and can be appreciated to the full only by bird photographers themselves. Of the outstanding photographs of birds at the nest there is, on p. 55, an excellent photograph of a female hen-harrier at the nest by T. M. Fowler, and, on p. 69, a remarkable photograph of a male Montagu's harrier carrying home food. This was taken by Walter E. Higham. Eric Hosking lives up to his high standard of bird photography by his picture (p. 73) of a barn owl taken by flashlight. Fred Jefferson shows (p. 77) a fine photograph of a water ousel, taken at close range, bringing a billful of food to her family, and Arthur Gilpin (p. 63) has been most successful with a very difficult subject—a tree creeper.

Two photographs from the portfolios of the late G. B. Kearey are shown, one of them a singularly beautiful picture of a hen capercaillie—a shy and difficult bird to photograph—approaching the nest.

We are shown the late C. J. King's classic photograph of a greater black-backed gull, taken so long ago as 1910—a grand picture. One of the most beautiful photographs in the book is that of a sand-martin taken by L. H. R. Lowes ; one cannot look too long at it. Perhaps the rarest photograph, which must have been most difficult to take, is that (p. 99) of a chough, taken by W. W. Nicholas. The chough, nesting in caves, is a hard bird to picture, and I do not remember having seen a good photograph of it before. Niall Rankin's classic photograph of a gannet alighting at the Bass Rock appears on p. 107. A remarkable study is J. E. Ruxton's picture of a pair of black-throated divers sitting side by side on the nest ; the 'happy expression' on the face of one of the birds is clearly seen. H. Morrey Salmon's photograph of a pair of herons at the nest is a delicate and attractive piece of work. On p. 119 is a remarkable photograph of a swallow in flight taken by J. A. Speed, and on p. 131 Ian M. Thomson has an excellent picture of a pair of Montagu's harriers.

Finally, Hugh G. Wagstaff's skill in bird photography is seen in two outstanding photographs—one of a buzzard eating a rabbit on a hillside, the other of a pair of merlins exchanging forceful remarks at the nest.

This is one of the most interesting bird books that have been published for a long time.

Seton Gordon

THE CLINICAL ASPECT OF PREVENTIVE MEDICINE

Preventive Medicine and Public Health

By Prof. Wilson G. Smillie. Pp. xvi+607. (New York : The Macmillan Co. ; London : Macmillan and Co., Ltd., 1946.) 6 dollars ; 30*s*. net.

PREVENTIVE medicine is the offspring of clinical medicine. Thomas Sydenham re-interpreted the Hippocratic conception of epidemics and led the way to the domain of modern epidemiology. The science of preventive medicine began in the eighteenth century, through the work of medical practitioners, like Huxham, Mead, Heberden, Fothergill, Haygarth, Willis and Withering, observers of the clinical features of epidemic disease, the influences of external environment, the paths of contagion and infection, and the effects of climate and season. University education in preventive medicine was initiated in 1768 by Johann Peter Frank, director of public health in Austrian Lombardy, and his international fame led to the creation of the first chair of public health in the University of Edinburgh.

Unfortunately, the specialization of public health for a considerable time brought about a dichotomy between preventive and clinical medicine. This was partly due to the beliefs of Edwin Chadwick, a pioneer in English sanitary reform ; he held that all zymotic and other diseases were due to filth, and that clean living, improvement of water-supplies, refuse removal, and bettering the houses of the workers would bring about a reduction in the death-rate and the restriction or extinction of pestilences. These views ignored the knowledge gained by Sydenham and the epidemiologists of the eighteenth century on epidemic infection and morbid contagia. Bacteriology afterwards demonstrated that environmental hygiene, while of great value in preventing much morbidity and mortality, was not the whole explanation. The victim of the disease and the human carrier claimed attention as well as his surroundings. More recently, prevention has extended its sway into the study of sociology, eugenics, inheritance, race, nutrition and a hundred other subjects, embraced under the comprehensive term of 'social medicine', which disturb health and favour disease.

Tradition dies hard, and the instruction of medical students has not moved with the times. For many years it has properly been deemed desirable that instruction should be given in public health and preventive medicine in the medical courses of Great Britain and the United States. Yet too much attention is still devoted to details of sanitary engineering, drainage and sewage disposal. The student, with an overcrowded curriculum, is thus led to regard preventive medicine as a subject apart instead of one which should be closely integrated with his clinical studies of disease. It is satisfactory to know that a revision of undergraduate instruction in Great Britain is under consideration from this point of view.

Prof. Wilson G. Smillie's text-book has been written for medical practitioners and students to inculcate the sound doctrine that preventive medicine is an essential part of the practice of clinical medicine. It is a comprehensive treatise. The introduction gives a brief and lucid history of public health in the United States, including reference to the work of Lemuel Shattuck, a Boston bookseller, whose "Report of a General Plan for the Promotion of Public and Personal Health", published as a legislative document in 1850, became a foundation stone for public health and preventive medicine in the United States. Section VI of the book provides an admirable account of American public health administration which may be read with profit by all interested in this important aspect of social medicine. It is of interest to note that Paul Revere, immortalized in Longfellow's poem, was chairman of one of the first local boards of health, organised in Boston in 1798.

The whole field of preventive medicine is broadly surveyed, with emphasis upon the clinical aspect and the study of the individual. The material presented is based on clinical experience and illustrated by actual case-histories. Another good feature of the book is that the author gives references to articles in American medical journals, which enable the reader to extend his knowledge of special subjects. The book is not a system of preventive medicine, for the field covered is so wide that the author has had to compress his accounts of environmental hygiene communicable and other diseases, child hygiene and adult diseases and their prevention into brief compass ; and not all epidemiologists would agree with certain of his conclusions, for example, the statement made on p. 199 with reference to poliomyelitis that "there is little evidence that the patient himself is an important source of disease dissemination", a statement which seems to conflict with a footnote on the same page. The advanced student of preventive medicine must, therefore, supplement hi studies by more extensive reading, but he could hav no better introduction to the subject than Prof. Smillie's book.

Arthur MacNalty

METALS AND GASES

Controlled Atmospheres for the Heat Treatment of Metals

By Ivor Jenkins. Pp. x+532+60 plates. (London: Chapman and Hall, Ltd., 1946.) 50*s*. net.

COMPLETENESS of the field covered, with authoritative discussion of both theoretical and practical aspects of the subject, make Mr. Jenkins' volume a book which will undoubtedly become a standard work of reference. It is particularly welcome, in that it possesses the additional merit of being written throughout in a concise and interesting manner. It is probable that in many cases the practical worker will not desire to study all the theoretical background of the technique which he is employing; but the arrangement of the material is such that the more practical aspects can be separately considered. At the same time the theoretical side is dealt with in a manner which will be of real interest and value to the more academic reader, and the author's intention of bridging the gap between the practical and academic aspects of the subject is successfully achieved.

The use of special atmospheres in the heat treatment of metals has assumed greatly increased importance in recent years, but the information has been scattered, and the wide range of applications dealt with in the present volume will probably surprise many readers. On one hand, there are the various atmospheres used to prevent oxidation, carburization or decarburization of steels during heat treatment, or to avoid oxidation or selective depletion of surface layers with non-ferrous materials. The composition of such atmospheres must often be designed as a compromise, balancing the conflicting tendencies of the various equilibria over the range of treatment conditions, and making the problem much less simple than might appear at first sight. On the other side are those conditions where composition and treatment are deliberately adjusted to obtain carburization or nitriding of steels, and in these cases, factors such as depth of case and concentration gradients may become of first importance.

The complexity of treatment which may be involved is well illustrated from the description of steel carburizing technique. Thus in certain cases the material may first be treated under slightly decarburizing conditions to activate the surface, and then subjected to carburizing treatment, involving the three stages of low-temperature sooting, carburization proper, and diffusion of the carbon to give the desired concentration gradient. Finally, the material must be heated for hardening in an atmosphere such that surface decarburization does not occur. These and the many other successful applications of controlled atmospheres are discussed theoretically and practically in some three hundred pages dealing with industrial applications, while earlier sections of the book deal in detail with the generation, purification and analysis of the various types of atmosphere employed.

While there may occasionally be some difference of opinion as to the precise value or interpretation to be put upon some of the published data quoted in the more theoretical sections, the careful survey of this material which the author has included throughout the book is a most valuable feature. In view of the detailed consideration given to carburizing and nitriding treatments, it would have been interesting to have had some reference to the role of gases in metallic cementation; but otherwise the ground covered is remarkably complete.

The usefulness of a book can be considerably affected by the clarity of its presentation. In the present case, author and publishers are to be congratulated, not only on the general arrangement and typography, but also on the wealth of excellent illustrations, which are a most valuable feature of the book.

C. S.

FOUNDATION OF THE JOHNS HOPKINS HOSPITAL

The Johns Hopkins Hospital and the Johns Hopkins University School of Medicine

A Chronicle. Vol. 1. Early Years, 1867–1893. By Prof. Alan M. Chesney. Pp. xviii+318+37 plates. (Baltimore, Md.: Johns Hopkins Press; London: Oxford University Press, 1943.) 18*s*. 6*d*. net.

THE reputation of the Johns Hopkins Hospital was founded upon the inspired endeavours of a few great men, and in this volume Prof. A. M. Chesney gives the story which he has unearthed from documents in the archives in the Hospital and in the University. The result is a work which will be very acceptable to all who are interested in the history of medical education. There are many strong ties between the Johns Hopkins and Great Britain—probably the greatest of which was its gift to us of William Osler, who left the Johns Hopkins in 1905 to take the regius chair at Oxford.

The year 1867 marks the foundation of both the University and the Medical School, since in that year Johns Hopkins caused to be introduced into the General Assembly of Maryland bills authorizing the formation of two corporations to found and administer these separate—though closely connected—institutions. His choice of trustees stamped Johns Hopkins as a man of great discrimination, as his scheme had shown him to be a man of wide vision. The University opened its doors in September 1876 with a "Faculty of Philosophy" consisting of six professors and their assistants. Huxley delivered the address at the opening ceremony. Almost straight away, under the direction of its enlightened president, Daniel C. Gilman, the University introduced courses in the basic sciences required by medical students. There were many unavoidable delays in the building of the Hospital, and it did not open its doors for patients until May 1889. The four luminaries who had been induced to take up the leading professional posts are portrayed in Sargent's well-known picture—William Osler (medicine), W. S. Halsted (surgery), Howard A. Kelly (gynæcology), and Welliam H. Welch (pathology). The rapidity with which these four men built up a distinguished reputation for the Hospital is well known.

Prof. Chesney's careful work gives much about the lives of these four men, but it will be valued even more for the brief lives of other giants who are less well known in Great Britain—W. S. Thayer, J. M. T. Finney, J. J. Abel, Franklin Mall, W. H. Howell, and many others. As a guide to the difficulties which beset the foundation of a new institution the work will naturally have great value. We look forward to the appearance of the remainder of this history.

E. ASHWORTH UNDERWOOD

AN ELECTRICAL HYPOTHESIS OF CENTRAL INHIBITION

By C. McC. BROOKS*

AND

PROF. J. C. ECCLES, F.R.S.

Physiology Department, University of Otago, New Zealand

AN electrical hypothesis of synaptic transmission has recently been proposed[1,2] which was based upon generally accepted data pertaining to the structural features of the synapse and to the electrical and excitatory properties of nerve and muscle. This hypothesis offered the first precise explanation of the temporal course of the excitatory events occurring during synaptic transmission. However, it gave no explanation of inhibition, which is so fundamental a counterpart of excitation in the functioning of the central nervous system. The hypothesis here formulated as an extension of the excitatory hypothesis rectifies that deficiency, and is likewise able to offer the first precise explanation of the temporal course of inhibition in terms of generally accepted structural and functional properties of neurones and of the synaptic contacts between them.

The development of such a hypothesis is the more necessary because the following carefully designed experiments have recently shown that inhibition of spinal reflexes occurs under conditions that preclude its explanation by all the theories hitherto elaborated[3,4]. The myotatic (stretch) reflex involves a single synaptic relay in the spinal cord with a synaptic delay of about 0·7–1·0 msec.[5–10] that is, centripetal impulses from a muscle entering via the dorsal roots pass directly via the reflexo-motor collaterals[11] to synapses on the motoneurones of that muscle. Inhibition of such a direct reflex pathway is produced by impulses from antagonistic muscles entering the spinal cord slightly before (0·2 msec.) or even simultaneously with the excitatory volley, that is, the central inhibitory time is no more than 1·0–1·1 msec.[3,6,12–15]. This inhibition is observed even when the respective excitatory and inhibitory pathways converge on the motoneurones from diametrically opposite directions[12]. Two arguments have been derived from this evidence. (i) The inhibition is exerted *directly* on a two-neurone arc and cannot be explained by any theory[16–20] that involves refractoriness or subnormality of interneurones or some failure of summation due to temporal discrepancy in synaptic bombardment. Furthermore, it must occur within the confines of the motor nucleus and hence be exerted either in the presynaptic terminals[14] or on the motoneurones themselves[3]. (ii) The short central inhibitory time shows that the inhibitory impulses act with no more synaptic delay than the excitatory impulses; hence it is argued that there are likewise no interneurones in the inhibitory pathway. However, it will be shown below that this latter inference is not valid.

Thus there has been a return[3] to the original concept of Sherrington[21–23], that there are converging on motoneurones two sets of impulses: those exciting and so tending to cause the reflex discharge of impulses, and those directly opposing this influence. In regard to the mechanism of this inhibitory action, there has been no theoretical advance beyond three vague suggestions: (1) that the inhibitory impulses block the excitatory impulses in the presynaptic terminals[14], presumably by some anelectrotonic action[24,25]; (2) that the inhibitory effect is exerted on the motoneurones because the inhibitory impulses terminate in some special spatial pattern on the motoneurone, for example, around the axon hillock[12,26–28]; (3) that there are specific inhibitory synapses at which presynaptic impulses exert an effect which is the functional opposite of excitation[3,12].

None of these is satisfactory. Renshaw's[14] experimental support of the first is susceptible of alternative explanation[29], and, as Lloyd[3] points out, it is difficult to conceive of impulses affecting the terminals of fibres in a motor nucleus without at the same time acting on the motoneurones. Actually such a secondary block is directly demonstrable, but only as a secondary phenomenon some milliseconds after the onset of inhibition[29]. In mammalian motoneurones there has been no demonstration[30] of any specific spatial distribution of presynaptic terminals such as occurs with Mauthner's cell[27]. Nor has there been any histological evidence of two distinct types of synapse[27,30] such as would be expected on the third suggestion. In this connexion there has been, of course, an attempt to explain inhibition as due to the liberation of an inhibitory substance antagonistic to an excitatory transmitting substance, but no evidence supports such a contention, and it now seems probable that the peripheral excitatory transmitter, acetylcholine, plays no part whatsoever in central synaptic transmission[31].

None of the above objections can be offered against the hypothesis developed here from the following assumptions, which are based on well-established properties of neurones and their synapses.

(*A*) The synaptic knobs closely investing the surfaces of the soma and dendrites of a motoneurone (and indeed of any neurone in the central nervous system) may be divided into two types which are intermingled on the surface: (i) those belonging to the long axons of neurones, including the dorsal root fibres (the reflexo-motor collaterals of Cajal); and (ii) those belonging to axons no more than 2–3 mm. in length. Following Cajal[11], the neurones with short axons will be called Golgi cells. They are now known to be numerous in the spinal cord as well as in the brain, and to be interpolated (hence the alternative names, internuncial neurone and interneurone, which, however, need not necessarily have such short axons) in most pathways between entering dorsal root fibres and motoneurones[11,32].

(*B*) The surface membrane of the soma and dendrites of a neurone has essentially the same electrical properties as the axon—see assumption *B* of the excitatory hypothesis[1,2]. For example, the soma is electrically excitable[5,33,34], and impulse propagation occurs over its surface presumably just as with the axon[34–37]. Its excitability is raised by catelectrotonus (outflowing currents) and decreased by anelectrotonus (inflowing currents)[25]. In addition, assumption *C* of the excitatory hypothesis[1,2] postulates a specialization of the immediate post-synaptic areas of the soma (and dendritic) membrane whereby they react to synaptic excitation by local responses[38] rather than by the all-or-nothing membrane breakdown characteristic of the propagated impulse. It is possible that the minute size of such post-synaptic areas is alone responsible for this specialized reaction.

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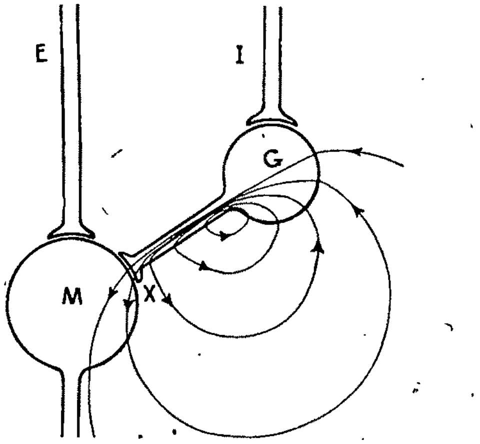

Fig. 1

(*C*) When a presynaptic impulse is propagated down to a synaptic knob on the surface of a neurone, it sets up a local response of the immediately adjacent post-synaptic membrane[1,2], which consequently is depolarized by diminution of its E.M.F. and resistance. Current flows from other areas of the neurone's surface (soma, dendrites and adjacent segments of the axon) into this relatively negative focus, thus producing the synaptic potential as recorded either by an adjacent focal (needle) electrode[34] or from the ventral roots[10,25,39]. If the synaptic potential is sufficiently large (that is, if a sufficient number of synapses is excited), the surface membrane of the neurone will be sufficiently depolarized, both intensively and extensively, to initiate the discharge of an impulse. If it is not, then after perhaps some spread of the active foci[34], the excitation dies out and the rebuilding of membrane potential gives the characteristic exponential decay of the synaptic potential.

These assumptions will now be applied in operating a schematic model (Fig. 1) of the simplest situation in which inhibition occurs. It has been shown by Lloyd[3] that the afferent fibres from a muscle excite the motoneurones of that muscle and its synergists and inhibit the motoneurones of its antagonists. The excitatory path is monosynaptic, and he has assumed from the similarity between the central excitatory and inhibitory times (each about 1 msec.) that this is also true for the inhibitory path. However, it will be shown that such similar timing is to be expected if a Golgi cell, *G*, is interpolated on the inhibitory pathway. Thus we have the excitatory reflexo-motor collateral, *E*, ending in a synaptic knob directly applied to the motoneurone, *M*, while the synaptic knob of the inhibitory fibre *I* (also a collateral of a dorsal root fibre) ends on *G*, which in turn has its knob on *M*. Many such knobs as those shown may be imagined covering the somas and proximal dendritic regions of *G* and *M* (assumption *A*).

If a volley of impulses which is being propagated to synaptic knobs of *I* fibres sets up a synaptic potential (assumption *C*) which is too weak to initiate the discharge of an impulse from *G*, current will flow as shown in the diagram during the whole temporal course of this potential; hence the axon (and inactive areas of the soma and dendrites) will act as a source for the current flowing in through the sink of the active areas. The size of the synaptic potential recorded from an emerging ventral root has shown that the axon acts as a considerable source of current even two or more millimetres from the soma[10,25,39]. With *G*, therefore, there will be, as shown, a considerable outflowing current from the synaptic knob of its axon, where the expanded area (due to branching as well as the swelling) of the highly resistant surface membrane gives favourable opportunity for current penetration. On account of the close synaptic apposition, this outflowing current will in large part penetrate the post-synaptic membrane of *M* (Fig. 1) and produce there a localized region of anelectrotonus, which will be a region of depressed excitability (assumption *B*). Of course, this penetrating current will also have to pass outwards across the surface membrane of *M*, leaving there a cathodal (excitatory) action, but such effects will be negligible in intensity because so widespread over the neurone and so much in the unstrategic areas of the dendrites. It is even possible that the *raison d'être* for the widespread dendritic branching is to provide the soma with a widely distributed surface for a dispersed return circuit through the grey matter.

Consider now the situation arising when impulses are fired simultaneously along several *E* and *I* fibres. The *E* impulses will produce local responses in the regions of *M* beneath their synaptic knobs, and, if of sufficient intensity, these responses will rapidly fuse and spread, generating the discharge of an all-or-nothing impulse (assumption *C*).

However, the *I* impulses are simultaneously producing local responses in *G* cells and so simultaneously causing anelectrotonic foci under the synaptic knobs which these *G* cells have on *M*. Thus the simultaneous *E* and *I* volleys give rise simultaneously to a mosaic of patches of local response and of anelectrotonus on *M*. The anelectrotonus suffers from the disadvantage that its rising phase will be somewhat delayed on account of its electrotonic spread from the soma of *G*, but the local responses on *M* also take a little time (usually 0·2–0·5 msec.[10]) to spread and fuse sufficiently to initiate the impulse discharge. Hence the anelectrotonic areas on *M* should just be able to exercise an appreciable depression on the spread of the local responses when the *E* and *I* volleys are simultaneous; and there should be a rapid increase in the depression as *I* is moved earlier relative to *E*, for then, as the local responses are being set up under *E* knobs, they will be presented with a well-established anelectrotonic mosaic.

According to the excitatory hypothesis[1,2], the synaptic potential generated in cell *M* by impulses in one set of *E* fibres is the cause of the facilitation of *M*'s reflex discharge in response to impulses in another set of *E* fibres[3,10]. Likewise the present inhibitory hypothesis attributes the inhibition of such a reflex discharge to the synaptic potential which impulses in *I* fibres generate in *G* cells. Hence the time courses of such facilitation and inhibition should be relatable to the synaptic potential and so to one another. This prediction receives striking confirmation from the recent determination of the time courses of the unitary excitatory[3,10] and inhibitory processes[3] set up by *single* *E* and *I* volleys uncomplicated by impulses relayed through interneurones (*E* and *I* curves of Fig. 2). It is evident that the respective hypotheses would predict the similar decaying phases observed for the two curves, for it relates both to the decay of the synaptic potential[10,34]. The differences in the early phases are also predictable. Simultaneous action of the two excitatory volleys would

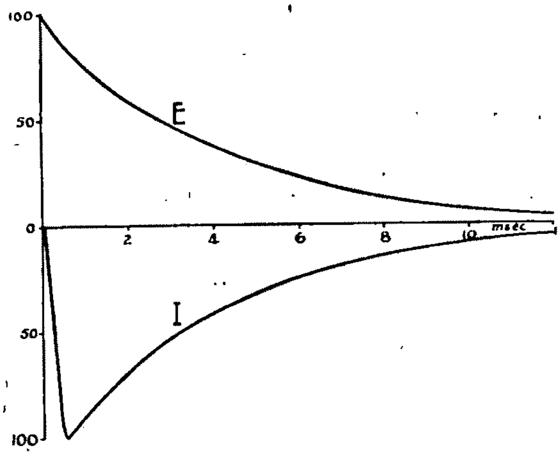

Fig. 2

give optimum conditions for summation of synaptic potentials, and hence the facilitation curve, *E*, would be expected to decay from a maximum with zero interval between the two *E* volleys[3,10]. On the other hand, we have seen that the inhibitory hypothesis predicts that the inhibitory curve, *I*, should rapidly increase from zero inhibition at about zero *I E* interval. Focal recording shows that the synaptic potential of the soma of the neurone (as distinct from that picked up from the ventral root[10]) takes about 1·0–1·5 msec. to attain its maximum[34], but the *I E* interval for optimum inhibition would be expected to be shorter than this, for the optimum would occur as soon as the developing anelectrotonic foci in *M* had an adequate start over the developing local responses of *M*. At an *I E* interval of 1–1·5 msec. the anelectrotonic foci would be fully developed when the local responses of *M* were being initiated, and would actually be decaying during the growth of these local responses; hence such an interval would be well beyond the optimum. The inhibitory hypothesis would thus predict the unitary inhibitory curve actually observed (*I* of Fig. 2) rising from zero to a maximum at about 0·5 msec. and then decaying with much the same time course as the unitary facilitation curve (*E*).

Hitherto it has been assumed that the *I* volley does not generate in *G* sufficient synaptic potential to evoke the discharge of an impulse. If this had occurred, the hypothesis would predict that the usual synaptic excitatory action would have ensued upon the arrival of the impulse at the synaptic knobs on *M*. Thus there would be an initial period of inhibition passing over to excitation about 1·0–1·5 msec. later. The additional delay would be largely spent in initiating the impulse in *G*, and in the synaptic delay involved in setting up local response under the knobs on *M* (cf. the excitatory hypothesis[1,2]). Lloyd (ref. 3, Figs. 8 and 10; ref. 4, Fig. 3) has observed precisely this transition after about 1·5 msec. from a primary inhibition to a secondary facilitation, and furthermore he finds it impossible to distinguish by threshold the afferent fibres responsible for these two effects. The slightest increase in the strength of the stimulus to the afferent nerve suffices to superimpose a secondary facilitation on a pure primary inhibition. In terms of the hypothesis, a slight increase in the *I* volley causes many *G* cells to discharge impulses, so generating the secondary facilitation of *M*. Thus the principle emerges that the synaptic knobs of a Golgi cell's axon have a pure inhibitory action or a diphasic inhibitory-excitatory action according as the synaptic potential of that cell is not, or is, adequate to evoke the discharge of an impulse.

On the other hand, at the synaptic knobs of axons more than a few millimetres in length such a situation would not arise, because no appreciable current would be generated there by synaptic potentials of the somas; and this would also obtain *a fortiori* for the dorsal root fibres, where the somas generate no synaptic potential. All such synaptic knobs would be purely excitatory. However, short collaterals arising from long axons close to the soma (the axon collaterals) would resemble the axons of *G* cells in being potential inhibitors. Hence arises a reason for the fact that the fibres of the long tracts in the spinal cord, for example, the pyramidal tract, end in synaptic relationship with Golgi cells and not directly with motoneurones[13,40,41]; for by so doing they become potential inhibitors as well as excitors of the motoneurones.

Reference to Fig. 1 reveals that according to the inhibitory hypothesis a needle electrode (insulated to the tip) close to the synaptic knobs of the *G* cells on the motoneurones, for example at *X*, would be expected to show a positive potential (relative to an indifferent electrode) having approximately the same time course as the inhibition. Positive focal potentials are indeed recorded from regions of inhibited motoneurones[14,28], but their time courses do not as a rule correspond with the inhibitory curves. In accordance with the hypothesis, blocking internuncial pathways by very deep anæsthesia shortens these positive focal potentials, so that their time course is similar to that of the negative synaptic potential[29]. However, under conditions giving unitary inhibition (hamstring afferents inhibiting quadriceps motoneurones), the focal potential may be negligible or show a very small positivity or negativity[29]. In evaluating such observations, it must be realized that, since the Golgi cells are interspersed between the motoneurones[19,32,41], their synaptic potentials may be recorded either as negativity or as positivity; for example, *X* in Fig. 1 might also be close to the somas of other *G* cells, recording their synaptic potentials as a negativity. Therefore the negligible focal potential set up by a hamstring afferent volley in quadriceps nucleus would be expected if its inhibitory action were due to the synaptic potentials that it set up in Golgi cells within that nucleus. Thus in testing the inhibitory hypothesis it will be necessary to study the spatial distribution as well as the time course of the focal potentials set up by inhibitory volleys.

The association of inhibition with a positive cord potential (recorded with leads on the surface of the spinal cord), and hence with anelectrotonus, has been widely recognized[16–18,20,42]; but in formulating theories of inhibition it has always been assumed that such potentials were homologous with the positive after-potentials of peripheral nerve, and hence always subsequent to the discharge of an impulse by a motoneurone or an interneurone. This is certainly not the case with direct inhibition, which is now known to play such an important part[3,4] that other mechanisms appear of but secondary importance. The production of anelectrotonus by the mechanism illustrated in Fig. 1 is the first attempt to give a coherent account of the mechanism of this direct inhibition'.

An argument against the present anelectrotonic hypothesis of inhibition is that during inhibition of motoneurones no positivity is detectable by ventral root recording[25], that is, on the axon of *M*, which on the contrary shows a large negative potential during the subliminal excitation of motoneurones[10,26,39]. However, the situations are not comparable, for with excitation the current will be flowing into the activated areas from other areas, including the proximal regions of the axon; whereas with inhibition the current generating the anelectrotonus will be flowing inward under the synaptic knobs and outward at other areas (Fig. 1). Thus the current flow in the ventral root will be just the same as with excitation, and hence during inhibition the ventral root potential should be in the same direction as with excitation despite the diametrically opposite effect on the soma. However, since it is generated extrinsically to the motoneurone, it would be much smaller than the synaptic potential.

The large 'stretch' afferents of a muscle excite that muscle and its synergists by a monosynaptic pathway and 'directly' inhibit its antagonists[3,4]. According to the inhibitory hypothesis, Fig. 3 gives the pathway for this reciprocal relationship between the flexors and extensors of a joint (the knee; *Q* quadriceps; *H* hamstrings) which we may regard as the simplest co-ordinative act of the central nervous system (cf. the classical figure of Sherrington[43]). The flexor and extensor 'reflexo-motor' collaterals end at synaptic knobs on the respective flexor and extensor motoneurones (*M*) and also give off collaterals[11] to Golgi cells (*G*), the synaptic knobs of which are reciprocally distributed to the extensor and flexor motoneurones respectively. Fig. 1 gives the key to the operation of Fig. 3 as a model of reciprocal innervation.

These illustrations suffice to show that the present hypothesis offers a precise and simple explanation of some inhibitory phenomena. Its performance is just as impressive in relationship to all other experimental observations that we have found in the literature. In particular, it should be noted that according to the hypothesis, inhibition is not a threshold phenomenon. All gradations of intensity can exist in the respective anelectrotonic and catelectrotonic areas of the mosaic on a soma, and the initiation of an impulse virtually will be dependent on their algebraic summation, much as was postulated for the excitatory and inhibitory states, C.E.S. and C.I.S.[21–23]. Thus the excitatory and inhibitory hypotheses may be regarded as developments from these original concepts, which so adequately fitted the literature up to that time.

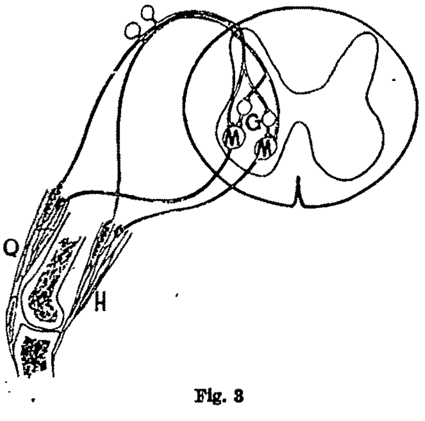

Fig. 3

The concept of the subliminal fringe has been fruitful in its application to reflex phenomena[23,44,45], but the present hypothesis gives new potentiality to it. Hitherto it has regarded the subliminally excited neurones (the subliminal fringe) as a transitional group available for facilitation. Now we postulate that the Golgi cells of the subliminal fringe are, in addition, acting as inhibitors of the neurones next in series. Thus with the exception of the monosynaptic reflexes, an inhibitory surround will encircle the active focus of a reflex; hence arises a ready explanation of simultaneous contrast, which is of such importance in the neural mechanisms of conditioned reflexes and of vision. In this latter connexion it is further to be noted that an inhibitory action of the retina is associated with a prolonged potential of opposite sign to the excitatory potential[46], and that there are many neurones of the Golgi cell types in the retina, for example, the bipolar and amacrine cells. The inhibitory function of the subliminal fringe may also provide the basis for an explanation of rhythmic reflexes, which hitherto have been so poorly understood[23].

The most interesting feature of the present inhibitory hypothesis is the dual role it gives to the Golgi cells. Undoubtedly these cells often act as excitatory links in reflex pathways which may eventually exert excitatory or inhibitory actions on motoneurones. Hence arises the familiar 'delay path' explanation of prolonged excitatory or inhibitory action[19,23,35]. Others may normally never be sufficiently excited to discharge impulses, and hence always function as inhibitors. But some would appear to function as inhibitors or excitors according to the degree of their own excitation; and, of course, any such Golgi cell in a chain would be able to act as an inhibitor of the Golgi cells next in series. Now Golgi cells arranged in the most intricate cross-linked chains form the outstanding feature of the structure of the higher centres of the brain[32,47]; hence the hypothesis that such cells are responsible for inhibition and may be either excitatory or inhibitory according to circumstances leads to the most interesting speculations. For example, in normal cerebral activity there is believed to be continual rhythmic discharges of cells with impulses circulating around neurone chains of unimaginable complexity. According to the hypothesis, we must assume in the normal waking state a delicate poise of Golgi cell activity giving a balance of excitatory and inhibitory action. If now any depression of cortical activity is brought about, the lowered excitation in the Golgi cells would cause the reversal of many from excitors to inhibitors, and hence deepen the depression; and conversely, raised excitation would convert inhibitors to excitors. Such reactions would seem to provide a clue to the understanding not only of the subtlety of reactions of the cerebral cortex, but also of its very great sensitivity both to narcotics and to convulsants. For example, narcotics not only would depress the excitation, but would thereby augment the inhibition. Likewise lowered cortical activity due to deprivation of most incoming sensory impulses would convert excitatory Golgi cells to inhibitors, so bringing about the widespread cortical inhibition that we know as sleep. Of course, a continued inhibition would be dependent on some continued cortical activity; hence active inhibition in the early stages of sleep would be expected to give place to mere inactivity. This parallels the observation that sleep lightens an hour or so after its onset[48]. Such examples illustrate how the hypothesis may be of value in understanding the functioning of the higher parts of the central nervous system.

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THE ROYAL ACADEMY, 1947

By Dr. A. TINDELL HOPWOOD

THERE are those who exhibit at the Royal Academy, and those who do not: there are those who visit the Royal Academy, and those who do not. Once the doors of the Summer Exhibition are opened, those who do either are of present importance and mutually dependent. The interplay of artist and visitor makes each new show a fresh adventure for anyone who is neither too ignorant to have acquired that sense nor so bored as to have lost it. Ignorant may seem a harsh word to use, but it is not unkindly meant. One cannot find intellectual adventure in that which one does not understand, but there is adventure in the effort necessary to understanding. For most people the annual adventure of the Academy consists in making the effort to understand. None but a favoured few can hope to escape the necessity of effort, since there are very few who can easily understand what an artist is striving to achieve. According to Michelangelo, "Good painting is a music and a melody which only the intellect can appreciate, and that with great difficulty". The same sentiment has been repeated by successive generations of artists, among others by the Academy's first president. This, if it be true—and there can be no argument about that—makes nonsense of the claim that 'art belongs to the people' taken in its usual connotation. On the other hand, it is true that art belongs to so many of the people as are willing to make the intellectual effort necessary for its comprehension. In art, as in all other human activities, one cannot have something for nothing.

Out of nothing, nothing is made, is just as true of artists as of spectators. The latter reveal the vacant mind by their chatter, the former reveal it in their works. Every year such minds are with us, but the Hanging Committee can usually find spots where their patients may linger in comparative obscurity. Perhaps it is unfair to introduce in this way an exhibition which is so much better than its predecessor, but I do not think it is. The higher the general standard, the more obvious do the babblers become; but it is also easier to close one's ears to their babble.

For the past fifty years there has been much noisy argument about the modern movement in art, and the modernists have shown a degree of intolerance equalled only by the intolerance of their opponents. The point at issue really boils down to whether line or colour is pre-eminent. The question is of small significance because each artist and each spectator will return that answer which best accords with his own temperament. There is no merit in denying the artistic worth of "Bol de Lait" by the late Pierre Bonnard, neither is there merit in praising it to the detriment of more academic canvases. Bonnard was a colourist and light was necessarily his primary interest. Now it is a curious thing that light, which reveals to us the planes and perspectives and all the geometry of Nature, ends by obscuring what it reveals. Turner knew this in his day, and M. Bonnard's picture is a restatement in a different idiom.

It is fitting that works by a great Frenchman should hang in the Academy, for it is from France that the moderns draw their inspiration; but one should not forget that the French themselves derive from an Englishman, John Constable, whose strivings after light were no less intense than those of Cézanne. Moreover, the inspiration from across the Channel must not blind us to the native interpretation of Constable's teaching. For this reason attention should be given to Sir Alfred Munnings' "Frisian Bull", in which the landscape suggests that his oft-expressed affection for George Stubbs is equalled by his affection for Constable. "Sketch of a Newmarket Start", which hangs a few feet from the bull, is full of a nervous vitality vastly different from the bucolic peace of the latter, and this tends to obscure the masterly skill with which the rhythmic motion of the jockeys and their mounts is conveyed.

One of the less good positions is No. 1. It is on a reverse wall, but has the compensation that most visitors look there when they are fresh, and before their energies have begun to flag. Here hangs "Once Upon a Time" by Lilian Jelly, noteworthy for its interpretation of texture and line. On the same wall, "Autumn", by Dame Laura Knight, is the first of three valiant and not unsuccessful attempts at rendering atmospheric effects of great difficulty.

The same room contains several pictures by younger artists, two of whom appear for the first time: "A Yellow Dressing Table" is by Pat Newton, and "Still Life" by Henry Kilvert. There are also three flower pieces, "Autumn Flowers", by Elsie Atkins, who exhibited in 1944 and 1946; "Summer Flowers", by Vera Waddington, also an exhibitor in 1944 and 1946; and "Geraniums", by D. Travers-Smith, whose picture last year was, I think, her first. Both Miss Atkins and Miss Waddington paint flowers well, and each has shown in previous years that she is not afraid of other subjects. The arrangement of Miss Travers-Smith's geranium is rather obvious, and the design is over-emphasized by the background. Best of all is the yellow dressing-table in its garret window; there is more originality in the subject, and more character in the painting.

One of Mr. Churchill's pictures hangs near the dressing-table. It is "Winter Sunshine", a not altogether successful sketch of a red-brick house standing in a snowy garden. The arrangement of the high lights, and the mass of shadow in the middle of the canvas, give the impression that the centre of the picture has dropped out. His other picture, said to be a later work, is in Gallery III. "The Loup River, Alpes Maritimes" is above the average in its rendering of flowing water. Taken together, they show Mr. Churchill to have considerable talent as a painter, but they display none of that robustiousness popularly associated with Mr. Churchill the politician.

If the Academy were restricted to oils, one might well stop there, for what has been said serves as a sample of the whole. As it is, there are other media to consider, and of them the water-colours in the South Rooms are easily the most important. Water-colour drawing is so essentially an English art that one is not surprised when its practitioners prove to be more consistently interesting than the painters in oils. R. Vivian Pitchforth, Barbara Jones, Hadley Rowe and Peter Lowry each has something worth saying, though Mr. Rowe should know better than to put tropical shells on what appears to be a typically English beach. Mr. Pitchforth is, of course, one of our leading water-colourists and an associate of the Academy, but Miss Jones and Mr. Rowe are, I believe, exhibiting for the first time. There is both character and individuality in their work. Mr. Lowry had pictures hung in 1945 and again last year; that he tends to dramatize his subject is not necessarily a fault. Two pictures of the shipyards at Appledore possess a maturity and sureness of touch which prove Michael Leszczyński to be much more than a beginner, even though this is the first time he has been hung in the Academy. Hal Yates' "Runswick" and Dennis James' "Snow Scene, Kingsley Way" each deserve more than a passing glance; the latter is not hung as well as it should be.

To return to the oil-paintings. Henry Hoyland has been represented by a picture or two since 1944, and, as his two studies of the circus show, he improves each year. Jean Primrose has two works of great promise in "Ballerina" and "Angela Reading", and that brings us to the Black and White Room (Gallery IX). This I found dull apart from Miss Winifred Austen's bird studies, which have a charm all their own, and Robert Austin's engravings. Sir Lionel Lindsay's dry-point is of particular interest: it throws a flood of light on his book "Addled Art".

There is little to be said about the architectural exhibits; present conditions are not kind, and architects are in partial eclipse. Neither is the sculpture very interesting. It is always difficult to make a gallery of small busts look anything but spotty, and this year the difficulties appear to have proved greater than usual.

Nevertheless, this is a 'good' Academy, and if the next can improve on it as much as this one has improved on last year's, then there will be firm reason for thinking that artists as a whole have recovered from their post-war malaise.

THE ADRENAL CORTEX

THE fourth meeting of the Society of Endocrinology, held on March 28 in the Department of Anatomy, University of Birmingham, was devoted to a discussion on the adrenal cortex. In the opening paper, entitled "Recent Advances in the Chemistry of the Adrenal Cortex", Dr. C. W. Shoppee mentioned briefly the six steroids newly isolated from adrenal tissue during the past seven years, which include œstrone, Δ^4-androstene-3 : 17 dione, and 17-hydroxyprogesterone. The total number of adrenal steroids with known structures is now twenty-eight, of which six are active in preserving the life of the adrenalectomized animal. The structures of most of these compounds are completely determined. Where hydroxyl groups exist at positions 3 and 11 they are (β) orientated, while hydroxyl groups at position 17 are almost certainly in the (α) position. During the past few years it has become clear that adrenal steroids, as well as deoxycholic acid, have the side-chain at position 17 in the (β) position and not, as was previously believed, (α) orientated. Reichstein has now prepared all six physiologically active steroids artificially. The molecular features essential for high activity appear to be a 3-keto-Δ^4-grouping, together with a 17 (β) side-chain of the form $-CO.CH_2OH$. For activity with respect to carbohydrate and protein metabolism, an oxygen atom at C_{11}, either as a keto-group or a (β)-orientated hydroxyl group, appears to be essential.

The pure crystalline substances isolated from cortical extracts represent only a small fraction of the activity of the concentrates from which they are prepared: the greater part of the activity (about 90 per cent) remains in the so-called amorphous fraction. The latter shows somewhat anomalous physiological properties, and it is likely that there remain to be isolated one or more unknown labile compounds, probably containing five oxygen atoms, which are more active than any of the hormones yet obtained in a state of purity. Lowenstein and Zwemer (*Endocrinology*, 39, 63; 1946) have recently reported the isolation of 11-dehydrocorticosterone and two incompletely characterized substances, the combined activity of which equalled 80 per cent of the activity of the original concentrate. One of these compounds gave ascorbic acid by mild anaerobic hydrolysis; the other, presumably steroid, product of hydrolysis has not been isolated.

In his communication entitled "The Pituitary–Adrenal Relationship", Dr. M. Reiss discussed first the problem of the isolation and biological assay of pituitary corticotrophic fractions. For assay purposes, Dr. Reiss and his colleagues have investigated the histological changes occurring in the adrenal glands of hypophysectomized rats. The sudanophilic substances between the zona glomerulosa and the zona fasciculata were found to disappear seven to ten days after hypophysectomy, the wide so-called sudanophobic zone thus formed being an enlargement of a very thin zone normally present in young rats. This zone is abolished by treatment of the hypophysectomized rat with corticotrophic extract, and a standardization of the extract is based on these histological changes. Workers in two different laboratories (those of H. M. Evans and of C. N. H. Long) have isolated, by different procedures, the same pure substance which they claim to be the corticotrophic hormone. This does not exclude the possible existence of more than one corticotrophic substance; and indeed when one considers the multitude of active substances produced by the adrenal cortex, the existence of different corticotrophic substances responsible for the mobilization of these adrenal steroids is by no means impossible. The influence of the known corticotrophic substance on the adrenal cortex is complex. The cholesterol content falls in the first three hours (rat) and later rises. A fall of ascorbic acid content is detectable an hour after corticotrophic treatment, and the fall is proportional to the dose given. By direct estimation the hormone content of the adrenal gland was found to be increased 24 hr. after treatment, but substantially reduced 48 hr. after (Hempill and Reiss, unpublished). The changes in the hormone activity of the blood were opposite to those of the adrenal tissue.

Although adrenal function is considerably diminished after hypophysectomy, there is no reason to believe that adrenal-cortical activity ceases in the absence of pituitary corticotrophin; the hypophysectomized rat can survive the avulsion a year or more, but it would die in the course of a few days if all the cortical tissue had been removed. Little is known about the nervous control of the pituitary anterior lobe production of corticotrophin, though it appears probable that the secretion of corticotrophin is influenced by a psychic factor. Although the physiological effects of corticotrophin are mainly to be ascribed to stimulation of the secretory activity of the adrenal cortex, it would not be surprising if some actions of corticotrophic extracts failed to agree with those of known adrenal steroids. It is probable that adrenal steroids remain to be isolated, while it is yet uncertain if all those isolated are of physiological significance.

In his survey of the "Adrenal Cortex and Metabolism (including Electrolyte Metabolism)", Prof. F. G. Young pointed out that at present no simple comprehensive theory seems able to explain the diverse actions of adrenal steroids, and as more experimental evidence becomes available the earlier generalizations seem less and less certain. It is important not to neglect the fact that when one injected a hormone one was studying not merely the effect of the hormone on the animal but also the interaction of the animal and the hormone. Changes in food intake, adaptation to newly imposed experimental procedures particularly in long-term procedures, metabolic interconversions of administered steroid substances, all could and probably do complicate the interpretation of apparently simple experiments. In particular, the control of food intake by paired-feeding control experiments is of the greatest importance. Conway and Hingerty (*Biochem. J.*, **40**, 561; 1946) have shown that the potassium ion content of the muscles of the adrenalectomized rat is raised. This controverts the idea that the increased blood potassium is to be ascribed to leakage of potassium ions from the tissue cells. These authors have also shown a striking increase in plasma and muscle magnesium ion content, possibly significant to the muscular asthenia of adrenal insufficiency. The influences of adrenalectomy on carbohydrate and protein metabolism can be largely prevented by adequate therapy with sodium chloride, although such treatment does not prevent the catastrophic fall in carbohydrate storage which results from a short period of starvation in the adrenalectomized rat. Since deoxycorticosterone and the amorphous fraction of adrenal extracts both possess striking activity in inducing retention of sodium chloride in the normal and adrenalectomized animal, it is perhaps surprising that these adrenal fractions have so little action on carbohydrate and protein metabolism. Moreover, an important *in vitro* action of adrenal extract on hexokinase activity has been traced to the amorphous fraction.

Cori *et al.* (*J. Biol. Chem.*, **160**, 633; 1945: *Fed. Proc.*, **5**, 150; 1946) have shown that the activity of hexokinase in catalysing the transfer of a phosphate group from adenosinetriphosphate to glucose, forming glucose-6-phosphate, is diminished *in vitro* by the addition of anterior pituitary extract, and that this pituitary inhibition can be emphasized and extended by the addition of adrenal extract, though the latter alone has no obvious action in this respect. The influence *in vivo* of adrenal extract on other enzyme systems (for example, arginase, phosphatase, cytochrome oxidase) has opened up new lines of investigation of the greatest significance. It seems possible that the adrenal hormones, like enzymes, are not essential for the mechanisms of the body, but hasten or retard reactions which will proceed in the absence of the hormones.

In discussing "The Adrenal Cortex in Shock and Stress", Dr. G. Ungar pointed out that there is good experimental evidence for three main conclusions: (1) adrenalectomized animals exhibit a lowered resistance to many different types of noxious stimuli; (2) the adrenal glands show morphological changes after exposure to these stimuli; (3) the administration of adrenal steroids can, in some instances, enhance the resistance of adrenalectomized animals to these stimuli. It has long been known that stimuli can sometimes induce in animals a temporary increase in resistance to the same and non-related stimuli. Selye has proposed the term 'adaptation syndrome' in this connexion, and divides this syndrome into three stages: the alarm reaction, the adaptation phase, and the exhaustion phase. Most of the symptoms of the adaptation phase cannot be induced in adrenalectomized animals, though the secretory activity of the adrenal cortex is not the only factor concerned. The influence of adrenal steroids on carbohydrate and protein metabolism, and on the involution of the thymus and lymphatic tissue generally, are of importance, but, as Dr. Ungar himself has shown, the spleen is also concerned. Noxious stimuli cause shortening of bleeding time, increase in capillary resistance, and reduction of capillary permeability. All these effects are prevented by hypophysectomy, or adrenalectomy, or splenectomy, and can be reproduced in appropriate circumstances by corticotrophin, whole adrenal extract and suitable spleen extract.

A substance which can account quantitatively for the action of cortical extracts is a recently isolated adrenal steroid, Δ^4-pregnene-3-one-17(β) : 20β : 21-triol. The active splenic substance has been obtained in very pure form, and its chemical identification is being carried out by Prof. E. L. Hirst in Manchester. During adaptation there is a reduction in the amount of histamine that can be liberated from blood cells. Histamine is liberated through the action of a proteolytic enzyme normally held in check by an inhibitor; in certain pathological conditions the enzyme is set free and is then able to split off histamine from some protein substrate. It is possible that the adrenal cortex can inhibit the liberation of the proteolytic enzyme.

In her consideration of the rate of secretion of the mammalian suprarenal cortex, Dr. Marthe Vogt first discussed the different methods available for the biological assay of adrenal cortical hormones. Most of the information on the amounts of cortical hormones present in body fluids has been obtained with methods involving the deposition of glycogen in the livers of fasting normal rats, or involving the protection of adrenalectomized rats against the effects of a low environmental temperature (Selye and Schenker assay). Dr. Vogt has successfully applied the second of these methods to the estimation of hormone activity in the suprarenal blood of experimental animals. The results were expressed, by comparison with commercial extracts prepared from slaughter-house adrenal glands, in terms of the amounts of slaughter-house material required for the preparation of crude extract sufficient to give the observed physiological activity. On this basis the normal output of adrenal hormones in a 10-kgm. dog is 720 gm./hr., which is approximately equivalent to 54 mgm./day of 17-hydroxy-11-dehydrocorticosterone.

These results confirm the idea that the hormones are not stored in the gland in the active form to any appreciable extent, but are produced from an inactive precursor and immediately released into the circulation. Furthermore, since arterial or heart blood contains no significant activity, it appears that the secreted steroids are rapidly inactivated in the tissues. The rate of hormone secretion is greatly increased by stimulation of the splanchnic nerves, and since this effect can be duplicated by the intravenous infusion of adrenaline, it appears to be an indirect one via the adrenal medulla. It has been found possible to assay the adrenal steroids liberated in the isolated perfused adrenal gland. In such a perfused preparation a prolonged increase in the rate of secretion can be induced by the addition of corticotrophin to the circulating blood. In the absence of any such added stimuli, the isolated glands have been found to secrete continuously at a steady rate which lies within the limits observed in the experiments on the whole animal. Experiments of this type are obviously of great value, since the conditions are much more experimentally controllable than those in experiments on the intact animal.

In the course of his summing-up of the discussion, the chairman (Prof. S. Zuckerman) pointed out the paradox that although extra dietary sodium chloride will maintain an adrenalectomized animal in good health under controlled environmental conditions, the secretory activity of the adrenal glands is normally surprisingly high and can rise to very high levels under the influence of environmental stimuli. What is the importance to the body of this normal secretory activity of the adrenal glands, and what is the fate of the secreted steroids ? Although the adrenal secretion may not be essential for survival under some conditions, and does not necessarily initiate reactions in the body but hastens or retards enzymically controlled processes, it is important not to under-estimate the importance of adrenal hormones, particularly under conditions of stress. The present multiplicity of apparently unrelated experimental data does not yet allow any simple generalization about the function of adrenal hormones in general; but the importance of correlating observations which can accurately be correlated in a limited way should not be neglected.

OBITUARIES

Dr. S. Monckton Copeman, F.R.S.

SYDNEY ARTHUR MONCKTON COPEMAN, the eldest son of the Rev. Canon A. C. Copeman, was born at Norwich on February 21, 1862, and was educated at King Edward VI School, Norwich, and at Corpus Christi College, Cambridge. After obtaining a second class in the Natural Sciences Tripos in 1882, he went to St. Thomas's Hospital and took the M.B. Cambridge in 1886. He proceeded to the M.D. in 1890 and was elected F.R.C.P. in 1899. For a short time he was assistant lecturer on physiology and morbid histology at St. Thomas's. In 1891 he became a medical inspector of the Local Government Board, and all his active medical life was spent in the service of that Department and, afterwards, as a medical officer of the Ministry of Health. In the same year he was one of the founders of the Medical Research Club.

Medical research early engaged Copeman's attention, and among his early papers was one on the specific gravity of the blood in disease and another on hæmatoporphyrin in urine. It is, however, by his work on variola and vaccinia that he established his scientific reputation.

The early experiments of Ceely (1839–40), of Badcock (1840) and of Klein (1892) had demonstrated that typical vaccinia may be produced in the calf by the inoculation of variolous matter. In 1892 Copeman showed that it was possible to inoculate calves with variolous lymph taken from a girl suffering from smallpox, that the inoculated calves showed vesiculation, that the results obtained became greatly modified in the course of successive removes, and further, that animals which had been thus treated were no longer susceptible to vaccination. In the same year he proved that rhesus monkeys are susceptible not only to vaccination but also to smallpox. He next investigated the degree of protection against smallpox afforded in the monkey by previous vaccination and the protection against vaccination afforded by variolation; and went on to compare the effect produced by the use of human and of calf vaccine respectively. By passing smallpox virus through monkeys and then vaccinating calves from the monkeys, he produced typical vaccinia, which gave excellent strains of vaccine lymph.

In 1865 a Commission, appointed by the Society of Medical Sciences at Lyons, having Chauveau at its head, had reported to the effect that cowpox and smallpox were dual diseases. Copeman's work supported the view that cowpox and horsepox are variola modified by transmission, or, as he phrased it: "Smallpox and vaccinia are both of them descended from a common stock—from an ancestor, for instance —which resembled vaccinia far more than it resembled smallpox".

In 1891, at the International Congress of Hygiene, Copeman described his technique for the bacteriological purification and preservation of vaccine lymph by the admixture of glycerin. This, as he observed, was no new device, but he was the first to demonstrate the selective action of glycerin in eliminating extraneous organisms from the lymph without affecting the specific virus. Later, with F. R. Blaxall, he showed that glycerin is superior to soft paraffin and lanolin in inhibiting the growth of these micro-organisms.

With Dr. Gustav Mann, Copeman collaborated in a study of the histology of vaccinia and investigated other aspects of variola and vaccinia.

As a result of Copeman's work, 'arm-to-arm' vaccination with its attendant risks was abolished, and vaccination was made a much safer and simpler operation. His work was generally adopted by the Royal Commission on Vaccination.

Copeman's discoveries are chiefly recorded in the *Proceedings of the Royal Society*, the annual reports of the Medical Officer of the Local Government Board, and in his Milroy Lectures under the title of "The Natural History of Vaccinia" (1898). He was elected a fellow of the Royal Society in 1903. He received many distinctions; for example, the Buchanan Gold Medal of the Royal Society in 1902; the Cameron Prize of the University of Edinburgh in 1899, and the Fothergill Gold Medal of the Medical Society of London in the same year; and the Jenner Medal of the Royal Society of Medicine (1925) and the Gold Medal of the International Faculty of Sciences (1938).

Although Copeman was employed in numerous administrative inquiries for the Central Health Department both at home and abroad, acted as Government delegate and served on many departmental committees, his real interest lay in scientific research, and his alert mind, fertile in new ideas, was directed to various subjects of investigation. During his later years at the Ministry of Health, he paid special attention to the problem of cancer, and his report with Prof. Major Greenwood on "Diet and Cancer with special reference to the Incidence of Cancer upon Members of certain Religious Orders" opened a new field of inquiry. In 1928, at the International Cancer Congress held in London, he read a paper on irradiated fluorescein in the treatment of cancer. He was a member of the Ministry of Health's Departmental Committee on Cancer, where his advice and ripe experience proved of much value. He was also a pioneer in immunization against diphtheria in Great Britain. During the First World War, Copeman was in charge of the Hygiene Department of the Royal Army Medical College, and helped with others to improve preventive medicine in the field. Endowed with untiring energy and enthusiasm, he took an active part in many medical societies and organisations. He was a keen naturalist and biologist and, as a member of the council of the Zoological Society, did much to develop its work on scientific lines.

On his official retirement in 1925, Copeman interested himself in local government as a member of the London County Council and chairman of the Public Health Committee of the Hampstead Borough Council. He died on April 11, at the age of eighty-five. To the end he kept himself informed of modern progress in medical research. He had a distinguished appearance and a generous and kindly disposition. A man of wide culture, he was a delightful companion. Copeman did much to maintain the high standard of English State medicine. A. S. MacNalty

Prof. W. L. Valentine

Willard Lee Valentine, editor of *Science* since January 1, 1946, died at his home in Alexandria, Virginia, on April 5. Sudden heart failure ended his career at the age of forty-two. He is survived by his wife, Norma Lawrence Valentine, and two children, Richard and Virginia.

Dr. Valentine was born in Chillicothe, Ohio, on December 2, 1904. He received the A.B. degree at Ohio Wesleyan University in 1925 and the Ph.D. at Ohio State University in 1929. During his years of graduate study, he served as assistant in mathematics and psychology, and later as instructor at Ohio Wesleyan and as instructor in psychology at Ohio State Universities.

Upon receiving his Ph.D. degree, he became a member of the Psychology Department at Ohio State University, first as assistant professor and later as associate professor. His duties there during 1929–40 were principally the direction and co-ordination of the work of the numerous instructors who gave the introductory courses in psychology. His strong interest in improving the teaching given to elementary psychology students led him during these years to write a manual of psychological experiments and to edit several collections of readings in psychology. His work during these years gave many students more interesting, and more experimental, courses than were often taught formerly.

In 1940 Dr. Valentine moved to Northwestern University in Evanston, Illinois, where he served as professor of psychology and chairman of the department until 1945.

From 1937 until his death he was treasurer of the American Psychological Association. During 1938–45 he served as business manager of the Association's publications. His careful supervision strengthened the journals financially, increased their number, and made them available to a steadily increasing group of subscribers.

His editorial skill and his experience with psychological publications led to his appointment as editor of *Science* when that journal came under the editorial direction of the American Association for the Advancement of Science. From the autumn of 1945, when he began planning his first issue, until his death, he devoted himself to making *Science* a news magazine of interest to workers in all fields of science. The format was improved and the scope of articles broadened. Material of general interest to all men of science, such as discussions of the Science Foundation bills being debated by Congress, became, under his editorship, a prominent feature of the journal.

His untimely death has ended a life of service to psychologists and scientific workers in other fields, just as Dr. Valentine was reaching his prime.

Dael L. Wolfle

Mr. C. W. Hobley, C.M.G.

Charles William Hobley died at his residence at Oxted, Surrey, on March 31 in his eightieth year. For the past six years or so his health had been frail and his activity was considerably reduced. He will be best remembered for his pioneer work for the prevention of the threatened extermination of some of the more graceful mammals. He was also an authority on the life, both human and wild, of East Africa.

Born in 1867, the son of William Hobley, of Chilvers Coton, near Nuneaton, Warwickshire, Hobley was educated at Mason College (now part of the University of Birmingham), specializing in geology. In 1890 he was appointed to a post as geologist in the service of the Imperial British East Africa Company, and as the result spent the whole of his official life in East Africa. When the region was taken over by the Government and became the East Africa Protectorate, Hobley was transferred to the administrative side, being appointed a sub-commissioner in 1894, and as time went on was allotted posts of ever greater responsibility. He was acting deputy commissioner from 1903 until 1904 and again from 1906 until 1907, acting commissioner in 1904, and acting senior commissioner in 1907. In 1912 he was placed in charge of the Seyidieh Province, and during 1912–20 he was an official member of the Legislative Council of the East Africa Protectorate as well as Commissioner of Mines. Upon the outbreak of the First World War, Hobley was appointed chief political officer to the British Expeditionary Force in East Africa, his services receiving mention in dispatches. He retired from the Colonial Service in 1921. He had been awarded the C.M.G. in 1904. An important valley on the east side of Mount Kenya was named after him.

All his life Hobley retained a keen interest in Nature, especially in East Africa, where he varied his official duties by making several extensive and important collections for the British Museum. He belonged to the Royal Anthropological Institute, the Royal Geographical Society, and the Geological Society, and served on the councils of the first two in 1931 and of the third in 1930; he was also a corresponding fellow of the Zoological Society. In 1930 he became a member of the Advisory Board of the Geological Survey of Great Britain. His greatest services were, however, rendered to the movement to provide protection for animal species which otherwise, owing to ruthless commercial exploitation, would seriously diminish in numbers. In 1923 he was appointed secretary of the Society for the Preservation of the Fauna of the Empire, and held the post for thirteen years, until in 1936 health reasons compelled him to take life more easily. In 1931 he represented the Society at the Second International Conference for the Protection of Nature held at Paris. It may be recalled that as an immediate consequence of this Congress a conference of the African Powers was held in London in 1933, which produced the Convention for the Protection of the Fauna and Flora of Africa now in force. His services to the Society were recognized by his election as vice-president.

Hobley married the daughter of the late Thomas Turner, of Sutton Coldfield, in 1905; she died in 1940. The son and daughter of the marriage survive.

G. F. HERBERT SMITH

Prof. Paul Reiss

PAUL REISS, *professeur agrégé* in the Faculty of Medicine at Strasbourg, was killed at St. Just (Cantal) on June 22, 1944, when helping to evacuate wounded members of the *Maquis*. He was forty-three years old. Reiss was born at Strasbourg. He was both personally attractive and one of the more brilliant of the younger French biologists. He was a pupil of Fred Vlès. His early work was on the relation of pH and rH to the physico-chemical equilibria in cells, from which he went on to enzyme studies, and thence to cancer work. He is buried in the crypt of the Sorbonne with others who fell in the Resistance Movement.

H. MUNRO FOX

WE regret to announce the following deaths:

Dr. Leopold Portheim, formerly director of the Biological Research Institute of the Academy of Science in Vienna, on May 21, in London.

Prof. W. Rogowski, professor of electrotechnics at the Technical Highschool, Aachen, well known before the War for his electrotechnical work.

NEWS and VIEWS

Research in Mechanical Engineering

THE Government, through the Department of Scientific and Industrial Research, is setting up a special organisation to carry out scientific research in mechanical engineering to meet and, still more, to anticipate, the needs of industry and Government departments. The eventual annual expenditure will be in the region of £250,000–£350,000, although it is unlikely that this figure can be reached for some years because of the present difficulties in obtaining suitably qualified staff and buildings. The activities of the new body are intended mainly to supplement the research carried on in other research organisations in Great Britain, and will largely be confined to those fundamental problems which underlie all mechanical engineering. Thus the subjects in which research is expected to be carried out are: (*a*) properties and strength of materials; (*b*) mechanics of solids, stress, stability and vibration of structures; (*c*) mechanics of fluids; aerodynamics, gas dynamics and hydraulics in their mechanical engineering applications; (*d*) lubrication, wear and mechanical engineering aspects of corrosion; (*e*) mechanisms, engineering metrology, and noise control; (*f*) mechanics of formation of materials; machine shaping of materials; (*g*) heat transfer, heat exchange apparatus and applied thermodynamics. The location of the research station has not yet been decided. For the time being much of the work will be carried out at the National Physical Laboratory, while other work will be arranged for at universities and other institutions. It is clear that the new station will have to work in the closest liaison with the N.P.L., which has a long tradition, in its Engineering Division, of engineering research of high quality, and which will provide the nucleus, in due course, of the new organisation. Unfortunately no land is available close at hand for the building of the new station, which will require a considerable area.

Dr. G. A. Hankins, superintendent of the Engineering Division of the National Physical Laboratory, has been appointed director of mechanical engineering research. As with all other research organisations in the Department of Scientific and Industrial Research, the director will be advised by a board, the members of which will serve in their personal capacity and not as representatives of any organisation to which they may belong. The composition of the Mechanical Engineering Research Board is as follows: Dr. H. L. Guy (*chairman*); Mr. L. Akehurst, operative, London Passenger Transport Board; Prof. R. N. Arnold, professor of engineering, University of

Edinburgh; Dr. S. F. Dorey, chief engineer surveyor, Lloyd's Register of Shipping; Sir Claude Gibb, of C. A. Parsons & Co., Ltd.; Dr. H. J. Gough, engineer in chief, Lever Bros. & Unilever, Ltd.; Sir William Halcrow; Mr. M. B. Hoseason, Brush Electrical Co., Ltd.; Dr. C. H. Lander, principal, Military College of Science; Prof. N. F. Mott, Melville Wills professor of theoretical physics, University of Bristol; Prof. D. M. Newitt, professor of chemical engineering, Imperial College of Science and Technology, London; Sir Ewart Smith, of Imperial Chemical Industries, Ltd.; Prof. H. W. Swift, professor of engineering, University of Sheffield; Dr. C. Sykes, director, Brown–Firth Research Laboratories.

British Committee for Co-operation with U.N.E.S.C.O. in the Natural Sciences

At the invitation of the Ministry of Education, the Royal Society has set up a committee to cooperate with the United Nations Educational, Scientific and Cultural Organisation in the field of the natural sciences. The Committee's terms of reference are: (i) on behalf of the United Kingdom, to co-operate with U.N.E.S.C.O. in the field of the natural sciences; (ii) to report to the Council of the Royal Society and to the Minister of Education.

The Committee consists of a chairman, Prof. E. D. Adrian (foreign secretary of the Royal Society), and representatives (as indicated in brackets) of the following bodies: Royal Society (Dr. C. H. Desch, Dr. J. Needham, Prof. H. H. Read); chairmen of the seven British National Committees (Astronomy—Sir Harold Spencer Jones; Biology—Prof. H. M. Fox; Chemistry—Sir Ian Heilbron; Geodesy and Geophysics—Prof. J. Proudman; Geography—Prof. H. J. Fleure; Physics—Prof. N. F. Mott; Scientific Radio—Sir Robert Watson-Watt); Ministry of Education (Mr. Ritchie Calder, Prof. H. J. Fleure, Sir Clive Forster-Cooper); Advisory Council on Scientific Policy (Dr. A. E. Trueman); British Association (Dr. E. Hindle, Dr. O. J. R. Howarth); British Council (Dr. N. Howard Jones, Miss Nancy Parkinson); Association of Scientific Workers (Prof. J. D. Bernal); Science Masters' Association (Mr. J. P. Stephenson); Department of Scientific and Industrial Research (Sir Edward Appleton); Medical Research Council (Sir Edward Mellanby); Agricultural Research Council (Sir John Fryer); secretary of the Universities Bureau of the British Empire; and *ex officio*, the president, treasurer and one secretary of the Royal Society. The joint secretaries of the Committee are Mrs. J. J. Hawkes, of the Ministry of Education, and Dr. D. C. Martin, assistant secretary of the Royal Society. In accordance with the proposal by the Ministry of Education, the Council of the Royal Society has agreed that other important scientific organisations in the United Kingdom should be notified of the existence of the Committee and invited to transmit to the secretariat any proposals which they may wish to initiate. The first meeting of the Committee will be held on June 27.

Agricultural Science at Newcastle-upon-Tyne

The scope of instruction and research in agriculture at King's College, Newcastle-upon-Tyne, is to be extended. Two new chairs have been founded, the occupants of which will carry out their work under the direction of Prof. R. W. Wheldon, the present head of the department. The Loveday Report recommended the setting-up of post-graduate schools in agriculture and farm machinery for graduates in engineering who intend to become agricultural engineers, and in engineering and farm machinery for graduates in agriculture who intend to become farm mechanization experts. King's College, which has a strong engineering school, has been selected as a centre for this specialized work.

Lieut.-Colonel Ewen McEwen has been appointed the first professor of engineering in the Faculty of Agriculture. At University College, London, in 1935 he gained a first-class honours in mechanical engineering. Until 1942 he held a research appointment with David Brown and Sons (Huddersfield), Ltd., and afterwards served with the R.A.O.C. and R.E.M.E. More recently, as assistant chief engineer in the Fighting Vehicles Design Department of the Ministry of Supply, he has become conversant with fundamental problems of traction in relation to soil structure.

King's College has acquired Cockle Park, Northumberland, where far-famed experiments on the control of grassland and on ley farming in general have been in progress for many years. It is intended to develop chemical, botanical and husbandry aspects of these experiments. With the appointment of Mr. Martin Jones to the newly instituted chair of agricultural botany, the further investigations of the botanical problems will be under experienced guidance. Mr. Martin Jones graduated in science at the University College, Aberystwyth (University of Wales). He has since done much work and published papers on plant breeding and grassland improvement. Under the auspices of Imperial Chemical Industries, Ltd., he was concerned with the early experiments on the effects of controlled grazing at Jealott's Hill. For a period he acted as an assistant to Sir George Stapledon. In recent years he has been advisory officer in grassland management at the North of Scotland College of Agriculture, Aberdeen.

South African Marine Expedition

The discovery of a living Cœlacanthid fish, *Latimeria chalumnœ*, in South African waters, off East London, at the end of 1938, is an event still in the forefront of the minds of biologists (see *Nature*, **143**, 455 and 748; 1939). The published account of the mounted animal is as exhaustive as the material permitted, but all zoologists desire information about the soft parts of the creature, which in this case were lost before they could be examined. The outbreak of war in 1939 put a stop to preparations for expeditions to seek further specimens of this remarkable fish. Now that the War is ended, general interest in this project has been shown in various countries, and in South Africa in particular. The South African Council for Scientific and Industrial Research has appointed a committee to consider how best to organise a marine expedition on a considerable scale. This expedition would aim not only at securing more cœlacanths, but would also explore and accumulate data in various fields of science in the relatively poorly known region of the Mozambique Channel. The committee is under the chairmanship of Dr. S. H. Haughton, director of the South African Geological Survey, and a member of the Council for Scientific and Industrial Research. The honorary secretary of the committee is Prof. J. L. B. Smith, of Rhodes University College, Grahamstown, and the committee requests that all societies, institutions and private persons interested in the project should communicate with him.

Refresher Courses for Science Teachers

TERMINATION of a student's normal course of study often brings to an abrupt end his active connexion with the university. In the case of science teachers, this is particularly undesirable, for it is important that the rapid developments which are taking place in their subjects should be fully discussed between school and university teachers, especially in relation to teaching methods. With these considerations in view, a ten-day course on modern aspects of chemistry was recently held at the University College of North Wales, Bangor, in co-operation with the Welsh Department of the Board of Education, one of the inspectors of which, Dr. D. M. Williams, assisted in the organisation of the course. Summaries were given of recent work on atomic structure, valency theory and its application to problems concerning the structure and reactions of some inorganic and organic compounds, the electro-chemistry of solutions, and the chemistry of natural and synthetic products of special interest; lectures and experiments were included illustrating advances in the theory and practice of *p*H determination, indicators, electrometric titrations, distillation, and chromatography, together with a demonstration of glass-blowing technique, a show of scientific films and a display of modern books, dealing especially with the subjects selected. While it was apparent that the teachers attending the course derived benefit and interest from it, the discussions proved most stimulating also to the University personnel who participated. The course was conducted by Prof. E. D. Hughes and Drs. W. R. Angus, I. Dostrovsky, J. Graham and D. R. Llewellyn, assisted in the experimental work by Dr. F. Brown, Mr. T. R. Jacobs, and senior research students; Prof. C. W. Davies and Dr. W. C. Evans, of University College, Aberystwyth, gave special lectures.

Library Service in Industry

A WELL-ATTENDED conference on "The Works Library", organised at Sheffield on March 27 by the Northern Branch of the Association of Special Libraries and Information Bureaux, was designed to help the budding works librarian to appreciate the scope of his work and the resources at his disposal. The chairman of the Conference, Mr. W. H. Higginbotham, chairman of Messrs. Edgar Allen and Co., Ltd., at the opening session, when the Association was welcomed by the Lord Mayor of Sheffield, emphasized the extent and diversity of knowledge required in industry and the importance of ensuring at all levels a sufficiency of knowledge and specialized information for the successful operation of an industrial or business undertaking, and of providing for its co-ordination and combination into an effective working tool. This is the essential task of the Association, and in the two papers presented at the morning session, "Pages from the Diary of a Steel Works Librarian" and "A Special Library in the Steel Industry", Mr. G. H. Davison and Miss A. R. Osborne gave some account of the building up of a library and information service for the United Steel Companies, Ltd., and for Messrs. Thomas Firth and John Brown, Ltd. Mr. Davison's paper in particular covered a wide range of problems in the organisation and running of a firm's library; Miss Osborne's paper was illustrated by lantern slides, and those attending the Conference had a further opportunity of seeing the actual functioning of the information service on the following morning when parties visited the Brown-Firth Research Laboratories. Other delegates availed themselves of the invitation of Messrs. Edgar Allen & Co., Ltd., to visit their works and laboratories. At the afternoon session Mr. E. N. Simons contributed a stimulating paper on "The Works Library of To-morrow", in which he suggested a number of probable trends in works library service during the next few decades. In the concluding paper, Mr. R. Brightman discussed "Reference Books for the Works Library", dealing with the needs of a library concerned with production rather than with research, and submitting a series of lists designed to help the novitiate in charge of such a library in the selection of his or her own desk tools, general reference books, technical reference books and single-volume textbooks of the 'refresher' type; in general he only included one-volume reference works.

Recent Earthquakes

OF the first three months of 1947, January was by far the most seismic. During January there were seven world-recorded earthquakes, besides minor shocks in many parts of the earth, including two near Switzerland and nineteen in New Zealand. The Americas, the Aleutian Islands and Japan provided the world-recorded earthquakes, the greatest being on January 26 at 10h. 06·7m. G.M.T. in western Nicaragua. This was a deep-focus earthquake, the focus being approximately 160 km. deep. The first shock near Switzerland was on January 16 at 22h. 30m. G.M.T., and was felt with scale V at Stein am Rhein, and the second was on January 24 at 2h. 30·5m. G.M.T., being felt at Westalpen Savoie, France. Nineteen local earthquakes and tremors were felt in New Zealand, the greatest being on January 10 at 16h. 08·8m. G.M.T. from 46·5° S., 164° E., which was felt with Modified Mercalli Scale IV at Puysegur Point.

During February there were two world-recorded earthquakes: on February 10 and 24, the latter having its epicentre in Japan. Several local tremors occurred, one of the largest being that on February 17 at 00h. 13m. at Piémont, France, with strength 5–6, being felt as far as Marseilles, Nice and Grenoble.

In March a strong earthquake occurred in China (epicentre 33·5° N., 100·0° E.) on March 17 at 8h. 19·5m. G.M.T., and on March 26, an hour after the Wellington Observatory, New Zealand, had reported a strong earthquake out at sea, the first seismic sea wave some 30 ft. high rolled up on a 60-mile stretch of the shore of Poverty Bay. This wrecked some waterside houses and shops at Gisborne and damaged some roads and bridges. At Gisborne some of the streets were 4 ft. under water. Half an hour after the first *tsunami*, a second arrived. Fortunately, the people on the sea-front saw the waves coming and got on to higher ground, so that no loss of life has been reported.

Institution of Mechanical Engineers: Centenary Exhibitions

IN connexion with the centenary celebrations of the Institution of Mechanical Engineers, during the week commencing June 8, an exhibition of Stephenson relics will be open to the public at the Institution at Storey's Gate, St. James's Park, London, S.W.1, during June 9–13 between 10 a.m. and 5 p.m. There are personalia and numerous prints, drawings and other material on loan from individuals and institutions.

A special exhibition is also being held in the Science Museum, South Kensington, during June 10–August 24 to commemorate the founding of the Institution in 1847. This exhibition, covering a century of mechanical engineering, is divided into several sections including mechanical plant for power stations; locomotives; automobile, marine and aero-engines; hydraulic and handling machinery, etc. Important historical objects are shown in their appropriate galleries. Modern exhibits are displayed in Gallery 1. Scale-models made specially for this exhibition include the steam turbines of the R.M.S. *Queen Elizabeth* and a Southern Railway 'West Country' steam locomotive. Most exhibits, such as automobile and aero-engines, models of high-pressure boilers, steam and gas-turbines, have never been shown in the Science Museum before.

Conference on Liquid Helium

A CONFERENCE on liquid helium will be held at the Clarendon Laboratory, Oxford, during June 27–28. The programme includes discussions on the general and quantum theories of liquids (Prof. Max Born and Dr. H. S. Green respectively), the 'cage' model of a liquid (Dr. H. N. V. Temperley), zero-point energy of thin helium films (Prof. N. F. Mott), properties of helium films (K. R. Atkins, J. B. Brown and Dr. K. Mendelssohn) and Heisenberg's new theory of superconductivity (Prof. M. H. L. Pryce). Particulars of the conference can be obtained from Prof. F. E. Simon, Clarendon Laboratory, Parks Road, Oxford.

Summer Symposium on Sound Absorption and Reverberation

THE Acoustics Group of the Physical Society is holding a Summer Symposium on June 26 at the Royal Institute of British Architects. The discussions will open at 10 a.m. with a paper on "Panel Absorbents of the Helmholtz Type", by Prof. P. V. Bruel, of the University of Gothenburg. In the afternoon Mr. J. Moir, of the British Thomson-Houston Co., Ltd., will speak on "Reverberation Time as an Index of Room Performance". The meeting is open to all who are interested in acoustics, but they are asked to notify the joint secretaries of the Acoustics Group at the offices of the Physical Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7, if they intend to be present, in order that necessary arrangements can be made.

Scottish Summer Schools in Health Education

EACH year the Scottish Council for Health Education sponsors three residential summer schools at convenient centres. These schools are of interest to doctors, teachers, health visitors, nurses, youth leaders and others, who feel that integrated courses in physiology, psychology and social medicine will help them in their professional work. The schools are residential, last for fourteen days, and provide a total of twenty-seven lectures by men and women eminent in their special fields. Students may enrol for an elementary or intermediate course at the Universities of Edinburgh and St. Andrews, respectively, both from July 26 to August 9, or take an advanced course at Strathpeffer Spa during August 8–22. There are still a number of vacancies at the Edinburgh and St. Andrews schools, but only a very few at Strathpeffer, which, already, has attracted nearly a hundred students. Further information can be obtained from the Secretary, Scottish Council for Health Education, 3 Castle Street, Edinburgh, 2.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. Harry Jones, reader in mathematics at the Imperial College of Science and Technology, to the University chair of mathematics tenable at the College as from October 1, 1946; Dr. Alan Kekwick, to the University chair of medicine tenable at Middlesex Hospital Medical School as from October 1, 1946; Mr. M. E. L. Mallowan, to the University chair of western Asiatic archæology tenable at the Institute of Archæology as from May 1, 1947; Mr. Mallowan has conducted excavations at Arpachinah, the first settlement of the Tel Halaf culture to be scientifically excavated, also at Chagar Bazar and in the Tel Brak district; Dr. H. W. Miles, during 1943–46 adviser and senior lecturer in agricultural entomology in the University of Bristol, to the University chair of horticulture tenable at Wye College as from May 1, 1947; Mr. R. S. Sayers, during 1935–45 lecturer in economics at Pembroke, Exeter and Corpus Christi Colleges, Oxford, to the Sir Ernest Cassel chair of economics with special reference to banking tenable at the London School of Economics as from May 1, 1947; Mr. Herbert Tout, senior lecturer in economics at the University of Bristol, to the University readership in political economy tenable at University College as from October 1, 1947; Dr. W. J. Hickinbottom, since 1927 lecturer in chemistry in the University of Birmingham, to the University readership in organic chemistry tenable at Queen Mary College as from October 1, 1947; Dr. E. S. Horning, formerly of the permanent scientific staff at the Imperial Cancer Research Fund Laboratories, to the University readership in experimental pathology tenable at the Royal Cancer Hospital as from May 1, 1947; Dr. F. C. Tompkins, lecturer at King's College, to the University readership in physical chemistry tenable at the Imperial College of Science and Technology as from October 1, 1947.

The title of professor emeritus of chemistry in the University has been conferred on Dr. James F. Spencer on his retirement from Bedford College. The title of professor of comparative education in the University has been conferred on Dr. J. A. Lauwerys in respect of the post held by him at the Institute of Education.

The degree of D.Sc. has been conferred on O. V. S. Heath (Imperial College of Science and Technology); and S. S. Joski (University College).

Announcements

SIR LIONEL WHITBY, regius professor of physic in the University of Cambridge, has been elected master of Downing College, Cambridge, in succession to the late Sir Herbert Richmond.

A NATIONAL meteorological service has been established in Portugal under the direction of Prof. H. Amorim Ferreira. The headquarters of the new service is Serviço Meteorológico Nacional, Largo de Santa Isabel, 2–Lisboa (Portugal).

THE following officers were elected at the annual general meeting of the Society for Endocrinology held at University College, London, on May 29: *Chairman:* Dr. A. S. Parkes; *Secretary:* Dr. S. J. Folley, National Institute for Research in Dairying, Shinfield, Nr. Reading; *Treasurer:* Dr. C. W. Emmens; *Editor of the Society's Proceedings:* Prof. S. Zuckerman; *Members of Committee:* Dr. P. M. F. Bishop; Dr. C. H. Gray; Mr. P. C. Williams; Prof. F. G. Young.

ERRATUM. In the communication "Temperature-Dependence of Magnetic Susceptibility of Annealed and Cold-worked Copper" (*Nature*, April 19, p. 537), par. 2, line 4, for "0·005 per cent" read "0·0005 per cent".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

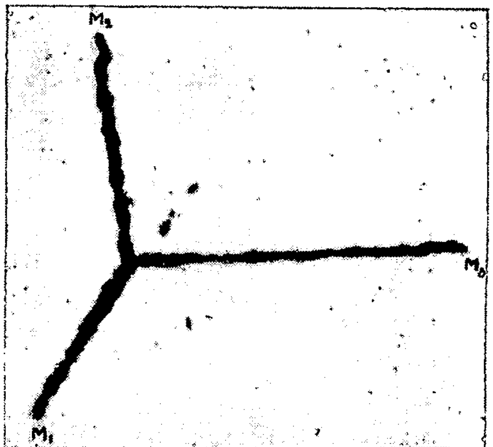
Ternary and Quaternary Fission of Uranium Nuclei

After our experimental proof of the existence of tripartition and quadripartition (ternary and quaternary fission) of U^{235} by means of photographic emulsion[1,2], a systematic study of the mass and kinetic energy of fission fragments has been made with the Ilford Nuclear Research C_2 plate. The experimental conditions were similar to those of previous work. C_2 plates soaked with 10 per cent solution of uranyl nitrate were bombarded with slow neutrons produced near the beryllium target of the cyclotron of the Collège de France.

The results of the first series of experiments can be summarized in the following[3,4].

Tripartition. Usually two of the fragments are heavy (m_1, m_2) and the third one is light (m_3) (Fig. 1). The mean ranges of m_1 and m_2 are 1·9 and 2·3 cm. of air equivalent, while that of m_3 varies from 2 to 44 cm., the most frequent value being about 25 cm. The direction of emission of m_3 is nearly perpendicular to that of m_1 and m_2. The mass distribution of m_1 and m_2 has mean values of 99 and 131, whereas in the usual binary fission the most frequent masses are 96 and 138. The third fragment, m_3, seems to have two probable values, one about 5, the other about 9. Some cases, which could be interpreted as tripartitions, could be also interpreted by the mechanism of projection of atoms of carbon, nitrogen or oxygen ($m \sim 14$) or silver or bromine ($m \sim 90$) by a fission fragment; fission tracks of this kind were not counted in the statistics of tripartition. The total kinetic energy of the three fragments, about 155 MeV.[5], slightly higher than that of the usual binary fission fragments (150 MeV.), is in good agreement with the theoretical prediction[6]. The frequency of tripartition is about 1/300 of that of bipartition (usual fission process).

A parallel and independent investigation by Demers[7] shows that the third light fragment (considered as an α-particle) is emitted within 2 × 10^{-14} sec. after the act of division. This is in good agreement with our hypothesis of tripartition, namely, that three fragments are emitted in an interval of time comparable with the mean life-time of the compound nucleus $_{92}U^{236}$. The frequency observed by Demers is also in agreement with ours.



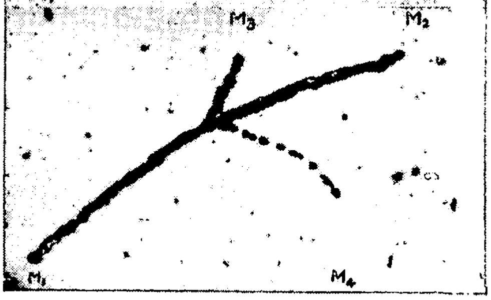


Fig. 2 (above); Fig. 3 (below)

Fig. 2. TRIPARTITION OF URANIUM NUCLEUS WITH THREE FRAGMENTS OF COMPARABLE MASSES: $m_1 = 127$; $m_2 = 77$; $m_3 = 32$

Fig. 3. QUADRIPARTITION OF URANIUM NUCLEUS

Recently, we have observed a particular case in which the third fragment is much heavier (Fig. 2). The calculated masses are about 127, 77 and 32 respectively. The three fragments are almost coplanar, their ionizations are much higher than that of α-particles and the total kinetic energy is about 142 MeV. This observation and the direction of emission of m_3 support the explanation in terms of tripartition[8,9] which is possible with a large positive amplitude of the deformation due to the fourth harmonic of the liquid drop (Bohr's liquid drop model of the nucleus). The relative sizes of the fragments (droplets) depend upon the amplitudes and the phases of deformations due to the second and fourth harmonics. Consequently, it is natural that the third fragment should have different values of mass such as we have observed. An analysis of fission fragments in the region of lower atomic weight by means of the mass spectrograph with a strong neutron source might give more information concerning the mass distribution of third fragment.

Quadripartition. The first case of quadripartition has already been published in detail[3,5]. Another one is shown in Fig. 3. The four fragments are not coplanar. The calculated masses are: $m_1 = 84$, $m_2 = 76$, $m_3 = 72$ and $m_4 = 4$, with a total kinetic energy about 90–95 MeV. If the internal excitation energies of the fragments are about the same both for binary and quaternary fissions, the observed total kinetic energy for the latter is in good agreement with that estimated by Bohr and Wheeler. The frequency of quadripartition is about 1/3,000 that of bipartition.

A detailed report of this work will be published shortly in the *Journal de Physique et Le Radium.*

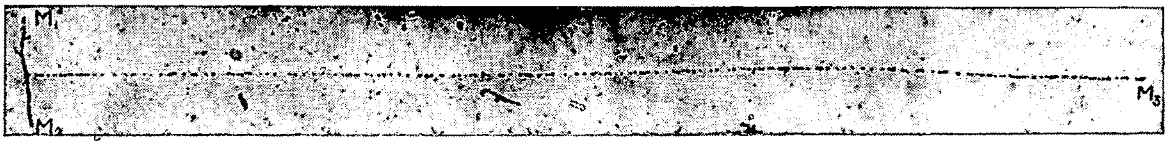


Fig. 1. TRIPARTITION OF URANIUM NUCLEUS WITH LIGHT THIRD FRAGMENT (ITS RANGE IN STANDARD AIR = 44 CM.). THE TWO BRANCHES ON M_1 TRACK ARE DUE TO NUCLEAR COLLISIONS OF M_1 WITH KNOWN NUCLEI CONTAINED IN PHOTOGRAPHIC EMULSION $m_1 = 110, m_2 = 120, m_3 = 6 \pm 1$. Total kinetic energy ~ 179 MeV.

Note added in proof.—Since this letter was written, two communications have appeared on the emission of a third light charged particle in the fission of uranium (L. L. Green and D. L. Livesey, *Nature*, March 8, p. 332 ; G. Farwell, E. Segrè and C. Wiegand, *Phys. Rev.*, March 15, p. 327). The first one, using the same technique as ours, gives similar results on the direction of emission and the range distribution of m_3 of range greater than 1 cm. of air equivalent. It shows, furthermore, the existence of an important short-range group. The second one, using the method of coincidence, gives 23 cm. as the maximum range of m_3 which has been identified as α-particle. Within experimental errors, the frequencies observed by these authors are in good agreement with ours.

In order to confirm the short-range group of m_3 indicated by Green and Livesey, we have re-examined our plates and counted those cases in which a short-range track is linked in the middle straight part of the main fission tracks. The statistics show that particles of range from 3 mm. to 3 cm. are present, the most probable range being about 8 mm. If all these tracks are really connected with the fission process, the frequency will be one short particle in 90 fission events.

Similar experiments have been made recently on the fission of uranium by fast neutrons. Short-range third light particles have been observed with the same frequency, but until now no long-range particle has been detected. Similar results have also been obtained in the case of fission of thorium by fast neutrons (observation made by the senior author in collaboration with Mrs. H. Faraggi).

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HO ZAH-WEI
L. VIGNERON
R. CHASTEL

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Collège de France, Paris.
March 15.

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[1] Tsien San-Tsiang, Chastel, R., Ho Zah-Wei and Vigneron, L., *C.R. Acad. Sci., Paris*, **223**, 986 (1946).

[2] Ho Zah-Wei, Tsien San-Tsiang, Vigneron, L., and Chastel, R., *C.R. Acad. Sci., Paris*, **223**, 1119 (1946).

[3] Tsien San-Tsiang, Ho Zah-Wei, Chastel R., and Vigneron, L., *C.R. Acad. Sci., Paris*, **224**, 272 (1947).

[4] Tsien San-Tsiang, Ho Zah-Wei, Chastel, R., and Vigneron, L., *Phys. Rev.*, **71**, 382 (1947).

[5] In the previous publications, the calculation of energy was based upon the *V—R* relation given by Bøggild, Bostrøm and Lauritsen (*Kgl. Danske Videnskab. Selskab. Math.-Fys. Medd.*, **28** ; 1940), assuming the total kinetic energy of binary fission fragments to be 162 MeV., instead of the more recent value, 151 MeV., from Flammersfeld, Jensen and Gentner (*Z. Phys.*, **120**, 450 ; 1943). Therefore, our formerly published total kinetic energy should be diminished by about 10 MeV.

[6] Bohr, N., and Wheeler, J. A., *Phys. Rev.*, **56**, 426 (1939).

[7] Demers, P., *Phys. Rev.*, **70**, 974 (1946).

[8] Present, R. D., *Phys. Rev.*, **59**, 466 (1941).

[9] Tsien San-Tsiang, *C.R. Acad. Sci., Paris*, **224**, 1056 (1947).

An Electron Accelerator with an Air-cored Field

ARISING primarily from the fact that iron becomes saturated in the region of 10,000–20,000 gauss, high-energy ions and electrons have been obtained from cyclotrons and betatrons only by the use of magnetic fields of large orbital radii. The question has, therefore, often been raised as to the possibility of using iron-free fields of short duration, especially as fields of the highest magnitude have been obtained in this way. The following note describes an experimental resonance accelerator for electrons which uses such an air-cored field.

The principle of the accelerator has already been described[1]. Electrons are accelerated by a 1,200 Mc./s. electric field across a pair of dees situated in a magnetic field of 425 gauss. Owing to the relativity mass increase, the electrons tend to lag behind the accelerating potential, and, in order to keep them in resonance, an increasing magnetic field is superimposed on the static field. The phasing condition requires that the rate of increase of magnetic field, dH/dt, be less than $2\, Ve\,.\,n\,.\,H_0/m_0\,c^2$, where Ve is the energy added to the electrons per transit of the dee gaps, n is the frequency of the accelerating field, and H_0 is the magnitude of the static field.

A focusing static field is produced by a Helmholtz pair of coils, each of 120 turns of mean radius 11·5 cm., excited by a direct current of 48 amp. The dynamic field is also produced by a Helmholtz pair, each coil of four turns and 7 cm. radius. A condenser bank of 0·0108 μf., charged to 20,000 V., is shorted across the dynamic coils and produces a field of approximately 300 gauss at the peak of a sinusoidal oscillation of 250 kc./s. frequency. The growth of the dynamic field is synchronized with the start of the electric field pulse by using the same rotary spark modulator to control both circuits.

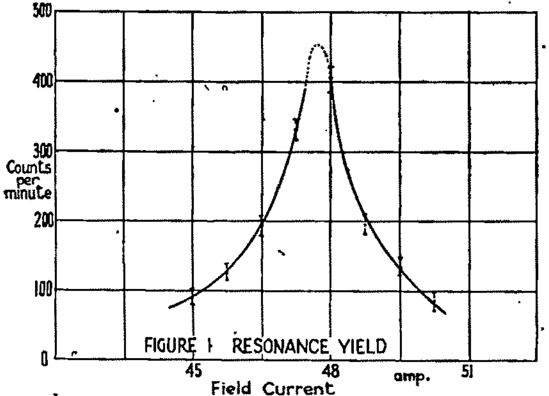
The dees are 2 cm. deep and 5 cm. in radius, and are constructed from wire hoops mounted perpendicularly from frames forming the dee gaps. They are situated in an evacuated glass vessel in the mid-plane of the Helmholtz coil system. The ultra-high-frequency is fed to the dees by a Lecher wire system which fans out to the width of the dee frames at the gaps. The oscillations are produced by a 25-cm. magnetron operating at 100 pulses per second, each pulse being of 1 μsec. duration, and of peak power up to 200 kW. The dee voltage is estimated to be of the order 1,000 V.

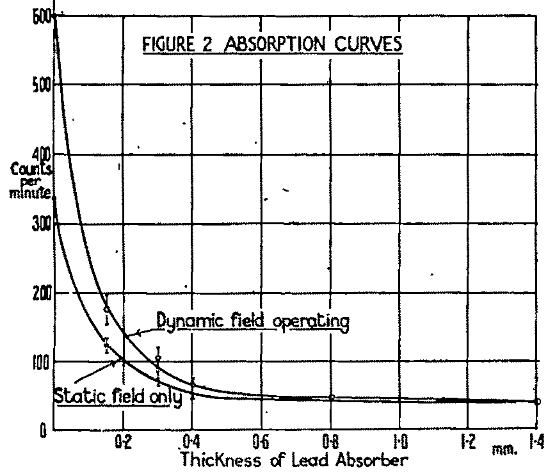
A tungsten filament, partly enclosed in a split cylindrical shield, is situated along the axis of the dees, and a small tungsten target is located at the periphery of one of the dees.

X-rays have been detected by a Geiger counter set up in the vicinity of the accelerator and are emitted at the value of the static field calculated for resonance with the electric field. The form of the resonance curve is shown in Fig. 1. Tests have been made on the X-rays produced both with and without the dynamic field operating. Absorption curves in lead are shown in Fig. 2. With the dynamic field operating it is clear that the X-ray yield is considerably increased, and there is an indication in the foot of the absorption curves that the radiation is also harder. The mean energy of the X-rays determined from the absorption coefficient in lead is approximately 60 kV.

For a constant magnetic field of 425 gauss, electrons should be able to reach energies of the order 0·5 MeV. before lagging 90° in phase behind the accelerating electric field[2]. In the present experiment, however, electrons will not attain energies greater than 100 kV. before they collide with the target at a radius of 4 cm. An experimental mean energy of 60 kV. is therefore not inconsistent with the upper limit, as it is improbable that many electrons will reach this maximum in the 1 μsec. acceleration time, and also as the radiation is from a thick target.

For a magnetic field which grows from 425 gauss to approximately 725 gauss in the micro-second acceleration-time, there should be a group of electrons which attain an energy as high as 300 kV., but an analysis of the energy spectrum to be expected of





the accelerated electrons has not yet been made. It might be added that the electron energy gained per turn as a consequence of the magnetic induction effect of the dynamic field is negligible in comparison with that gained from two transits of the dee gaps.

The X-ray yield, compared tentatively with a radium source, corresponds to 0·1 millicurie, which is equivalent to a minimum peak yield of 1 curie. The yield increases rapidly with increasing dee voltage, and a ten-fold increase is obtained for an increase of filament emission to the dees from 0·5 to 5 mA.

The accelerator described above was designed to use a 1,200 Mc./s. accelerating field, mainly because the size of the maximum orbit was suited to the construction of an experimental model; but the possibility of extending the method to accelerate electrons to high energies must be considered primarily in relation to the maximum dynamic fields which can be produced. The relationship of accelerating frequency and magnetic field to maximum electron orbit is to be seen in the accompanying table. Although fields of the order of megagauss have been obtained in small volumes, the dimensions of an accelerator using centimetre accelerating fields would raise serious problems. The most attractive combination of fields appears to be in the neighbourhood of 100 Mc./s., where the relatively low magnetic fields could probably be obtained for short periods.

VARIATION OF ACCELERATOR CONSTANTS

Frequency (megacycles)	3,000	1,200	300	30	12
Static field (gauss)	1,060	425	106	10	4
Dynamic field at 10 MeV.	22,500	8,900	2,250	225	89
Dynamic field at 100 MeV.	213,000	85,300	21,300	2,130	850
Maximum electron radius (cm.)	1·6	4	16	160	400

Acknowledgments of helpful discussion are due to Prof. L. H. Martin, and of funds and equipment to the Council for Scientific and Industrial Research.

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March 24.

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[1] Hill, R. D., *Aust. J. Sci.*, 9, 87 (1946).

[2] McMillan, E. M., *Phys. Rev.*, 48, 143 (1945).

Magnetic Dispersion of γ-Ferric Oxide

AN account of preliminary measurements of the magnetic properties of iron oxides at wave-lengths of 9, 6 and 3 cm. has been given in an earlier communication[1]. The powdered oxides were mixed with paraffin wax, and the properties of the mixtures determined by a wave-guide impedance method. These measurements have now been extended to a wider range of mixtures, and to wave-lengths up to 60 cm.

It has been found that the Clausius–Mosotti formula, previously used for extrapolating the properties of the mixtures to 100 per cent concentration, is of only limited validity. A more general relation between the complex permeability and permittivity, $|\mu| \exp(-i\mu')$ and $|\varepsilon| \exp(-i\varepsilon')$ of the mixture, and v, the proportion by volume of the oxide, has been determined. Within the limits of experimental error, $|\mu|$ and $|\varepsilon|$ obey a logarithmic law, of the type initially proposed by Lichtenecker[2] for dielectric mixtures, namely,

$$\log|\mu| = v \log|\mu_a|$$

$$\log|\varepsilon| = v \log|\varepsilon_a| + (1-v)\log|\varepsilon_0|;$$

and the magnetic and dielectric loss tangents vary linearly with v,

$$\tan\mu' = v \tan\mu'_a; \quad \tan\varepsilon' = v \tan\varepsilon'_a,$$

where suffix a refers to the properties of the oxide, and suffix 0 to those of the paraffin wax ($\log|\mu_0| = \mu'_0 = \varepsilon'_0 = 0$).

The modified values for the magnetic properties of γ-ferric oxide previously reported[1] are included in Table 1, giving the results of measurements from 58·5 cm. to 3·08 cm.

TABLE 1

λ in cm.	58·5	39·2	29·8	22·5	15·3	8·93	5·97	3·08
$\|\mu_a\|$	21	18	16·9	12·4	8·0	3·2	1·4	0·53
μ'_a	36°	45°	51°	57°	61°	67°	65°	32°

Huttig's measurements[3] at the longer wave-lengths gave much lower values for the permeability, but this is probably attributable to porosity in the compressed samples of the oxide which he used. On this hypothesis, comparison of his value of $\varepsilon = 5 \cdot 4$ at $\lambda = 39 \cdot 5$ cm. with my value of $\varepsilon = 24$ gives $v = 0 \cdot 53$. Using this derived value of v, Huttig's measurements of μ have been extrapolated to 100 per cent concentration, and the results are given in Table 2. The value at infinite wave-length is extrapolated from the measurements of Welo and Baudisch[4], who used packed samples of known density.

TABLE 2

λ in cm.	∞	174	77·5	39·5
$\|\mu_a\|$	31	28·6	23·4	17·9
μ'_a	0	~0°	29·5°	41°

The general consistency of these values with those in Table 1 is striking, considering the range of the extrapolations.

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March 17.

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[1] Birks, *Nature*, **158**, 671 (1946).

[2] Lichtenecker, *Phys. Z.*, **19**, 374 (1918).

[3] Ministry of Supply, S.I.G.E.S.O. Report.

[4] Welo and Baudisch, *Phil. Mag.*, vi, **50**, 399 (1925).

Interpretation of Complex Roots of the *S*-Matrix

It has recently been pointed out by Kramers and Heisenberg[1] that from the knowledge of the collision cross-sections between free particles, the energy-levels of the discrete states can be deduced. For this purpose the asymptotic wave function in the continuous spectrum (for one particle under the influence of a fixed centre of force),

$$\psi = \sum_l (2l+1) P_l \left\{ S_l(k) \frac{e^{ikr}}{r} - \frac{e^{-ikr}}{r} (-1)^l \right\} e^{-i\varepsilon t}, \quad (1)$$

is considered, where S_l is the diagonal form of the S-matrix and a function of the real momentum k. The stationary states follow then from the condition $k = -i\kappa$, and

$$S_l(-i\kappa) = 0, \qquad \kappa > 0, \quad (2)$$

and, for relativistic particles,

$$\varepsilon = +\sqrt{m^2 - \kappa^2}.$$

It is evidently necessary that $\kappa < m$. The upper half of the k-plane ($\kappa < 0$) gives only a repetition of the same physical facts if the roles of zeros and poles of S are interchanged.

It was further pointed out by Møller[2] that (2) can be generalized so as to give also the levels of decaying radioactive states with their decay constants, through the condition

$$\left.\begin{array}{l} S_l(k' - i\kappa) \doteq \infty \\ \varepsilon = +\sqrt{m^2 + k^2} = W - i\lambda \end{array}\right\} \kappa > 0. \quad (3)$$

If $k' > 0$, then also $\lambda > 0$ and

$$\psi_l \sim \frac{e^{ik'r}}{r} e^{-iWt} e^{+\kappa r} e^{-\lambda t}.$$

This describes an outgoing wave with decay constant 2λ (the exponential increase $e^{+\kappa r}$ is due to particles which have been emitted a 'long time ago'). For $k' < 0$, the wave-function describes just the reverse process. It is here evidently necessary that $W > m$. This condition defines a certain region $k'^2 < \dfrac{m^2\kappa^2}{m^2 + \kappa^2}$ in the lower half of the k-plane where poles are meaningless.

Møller stated that S_l can have no zeros in the right lower quadrant of the k-plane except on the imaginary axis, where the zeros give the stationary states with energy less than m. We wish to point out that, in certain modern theories where particles can be created and annihilated, complex zeros of S in the lower half plane also have a simple interpretation. Let $S_l = 0$ for $k = k' - i\kappa$, $\varepsilon = W - i\lambda$ ($\kappa > 0$). Consider first the case $k' > 0$, and therefore $\lambda > 0$. In every case the energy W must be positive. The wave function is then

$$\psi_l \sim \frac{e^{-ik'r}}{r} e^{-\kappa r} e^{-iWt} e^{-\lambda t}. \quad (4)$$

This describes an ingoing, decaying wave. As can easily be verified, the equation of continuity (conservation of particles) is satisfied in every point except at $r = 0$. The wave is therefore swallowed up by the centre of force. It is true that such solutions cannot occur in ordinary wave mechanics but can occur in theories, for example, in the meson theory, or the theory of β-decay, where particles can be created or annihilated. The capture of a *K*-electron would be one example. It is significant that in none of these theories is a convergent Hamiltonian known to exist. Again the case $k' < 0$, $\lambda < 0$ describes the reverse process. There is no restriction as to the value of W, except $W > 0$.

As an example for the Kramers – Heisenberg theorem for which no Hamiltonian exists, we have studied the S-matrix of a nucleon-meson system in the theory of damping[3]. Neglecting all multiple processes, and considering longitudinal mesons and the charged theory only, S is given by (only for $l = 0$, $S \neq 0$), putting the meson mass $m = 1$,

$$\left.\begin{array}{ll} S \doteq \dfrac{1 + ig^2 k^3/\varepsilon}{1 - ig^2 k^3/\varepsilon} & \text{for a proton and positive meson (total charge 2)} \\ S = \dfrac{1 - ig^2 k^3/\varepsilon}{1 + ig^2 k^3/\varepsilon} & \text{for a proton and negative meson (total charge 0)} \\ \varepsilon \doteq \sqrt{1 + k^2}. & \end{array}\right. \quad (5)$$

It was shown that for total charge 2 one stationary state with $k \sim -i$, $\varepsilon \sim g^2$ (approximately) exists, ($g^2 \ll 1$). Applying the foregoing to (5), we have in addition the following complex roots and poles of S, with positive real part of the energy:

$$\begin{array}{ll} S = \infty \text{ charge 2.} & k = \dfrac{1}{g}\dfrac{1 - i}{\sqrt{2}}, \quad \varepsilon = \dfrac{1}{g}\dfrac{1 - i}{\sqrt{2}} \\ & k = -\dfrac{1}{g}\dfrac{1 + i}{\sqrt{2}}, \quad \varepsilon = \dfrac{1}{g}\dfrac{1 + i}{\sqrt{2}} \end{array} \quad (6)$$

$S = 0$, charge 0. The same values of k and ε as in (6).

No solutions of $S = 0$, charge 2, or $S = \infty$, charge 0, exist with k in the lower half-plane (except with negative energies, which have to be excluded). Thus we see that a metastable isobar with charge 2 and energy greater than 1 exists, which decays exceedingly rapidly. For practical purposes, this state can be considered as free. Furthermore, a metastable state exists for charge 0, with the negative meson being swallowed up by the proton ($k' > 0$); and also the reverse process, with the negative meson emitted by the neutron ($k' < 0$). Such states are likely to occur in a theory where particles can be emitted and absorbed. This example is given as an illustration of the general theorem, but in view of the preliminary character of the theory of damping the results should not be taken as physical facts.

It appears that almost all zeros and poles of S have a simple physical interpretation. Certain regions only are meaningless : for poles the region $W < m$, and for the zeros the part of the imaginary axis $\varkappa > m$.

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March 4.

[1] Several as yet unpublished papers by Heisenberg. A complete account of them is given by Møller, ref. 2.

[2] Møller, *Kgl. Danske Vid. Sels. Math-Fys. Medd.*, **23**, No. 1 (1945) ; **22**, No. 19 (1946) ; *Nature*, **158**, 403 (1946).

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Units in Photo-Electric Absorptiometry

Koch and Kaplan's criticism[1] of the E (1 per cent, 1 cm.) value does not distinguish between absolute and abridged spectrophotometers[2]. The context indicates that only the abridged type (employing light filters) is in question ; yet E (1 per cent, 1 cm.) is an essentially monochromatic convention that strictly applies to absolute instruments only, and that pertains not to colorimetry but photometry. Moreover, E (1 per cent, 1 cm.) is merely a standard expression that does not carry the implication that one must measure the optical density of a 1 per cent solution in a 1 cm. cell any more than a determination of the coefficient of expansion calls for measurements on a 1 cm. length of material heated through 1° C.

The inherent difficulties of abridged spectrophotometry have been discussed elsewhere[2]. Briefly, resolution lies in the use of (i) a standard the absorption characteristics of which closely resemble those of the test solution, and (ii) a light filter the peak transmission of which (the band being as narrow as possible) corresponds with the peak of absorption of the standard and test solution. Measurements should never be made on the slopes of absorption curves. Under these conditions good approximations to E (1 per cent, 1 cm.) values can be derived.

Koch and Kaplan rightly recognize that measurements should invariably be made at approximately the same optical density. This principle is, or at least should be, embodied in standard practice, but the density chosen depends on the instrument ; for example, 0·43 is best for the ordinary photo-electric absorptiometer[3], and 1·2 for a photographic spectrometer[4]. No instrument known to us has its maximum sensitivity at the proposed optical density of 0·301 (that is, 50 per cent transmission).

The problem, therefore, reduces to the mode of expression of the absorption, and it seems to us that the well-established E (1 per cent, 1 cm.), obtained by extrapolation from the strength and optical density of the cell solution, has this important advantage over the 'half-value' $W^{50}_{1\,\text{cm.}}$

$$[= (\log 2)/100 \times E \text{ (1 per cent, 1 cm.)}] :$$

it is directly related to quantity, whereas the latter employs minute decimal fractions inversely related to quantity and consequently difficult to assess rapidly at sight.

Incidentally, may we take this opportunity of pleading for the adoption of "E (1 %, 1 cm.)" in place of "$E^{1\%}_{1\,\text{cm.}}$", which is not only inelegant typographically but also introduces an awkward piece of type-setting for the printer.

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Luminous Phenomena in Oxygen

PROF. J. KAPLAN[1] proposes the name 'active oxygen' for certain luminous phenomena observed by him "just as the name active nitrogen was given to similar phenomena in nitrogen". I write to point out that this is not historically correct. I say so with some confidence, having coined the phrase 'active nitrogen' myself[2]. The full title of the paper cited was "A Chemically Active Modification of Nitrogen, Produced by the Electric Discharge", and in the same paper it was shortened into "active nitrogen".

The chemical activity referred to was the combination with metals such as sodium and mercury, to form nitrides, and with organic materials to form cyanogen compounds.

Striking luminous phenomena often accompany these chemical actions, but it is wrong to regard these effects as the essence of the matter.

As a matter of fact, the number of nitrogen molecules which emit a photon of afterglow light is very small compared with the number which become chemically active. For this reason, I do not think that the afterglow should be regarded as the essential phenomenon of active nitrogen, and I do not think that in the present state of knowledge the term 'active oxygen' should be applied by analogy, when only luminous phenomena are so far known to be involved. This would only cause confusion. I may add that I am trying to compile a clear account of these matters.

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Influence of 2,3-Dimercaptopropanol (*BAL*) on Blood Coagulation

SINCE the announcement by Peters, Stocken and Thompson[1] of *BAL* as an antidote for lewisite, the compound finds increasing application in the treatment of poisoning due to arsenicals[2], mercury salts[3,4] and organic mercurials[5] in humans and animals. Substances containing —SH groups are known to influence blood coagulation, for example, thiosulphate[6], cysteine[7,8] and glutathione[9]. In preliminary experiments it was observed that *BAL* was more active as an anticoagulant than cysteine. This made desirable a detailed study of the influence of *BAL* on the components of the clotting system.

The —SH compounds were dissolved in Sørensen phosphate buffer $M/15$ to produce pH 7·1–7·5, and

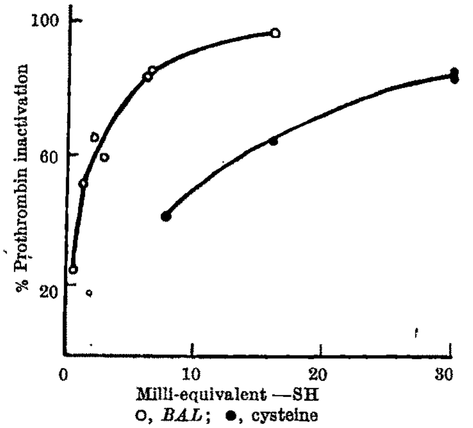
10 per cent of this stock solution was added to human oxalated plasma. The maximum effect on inhibition of coagulation was obtained after 15–30 minutes incubation at 20–28° C. Prothrombin determinations were made according to Quick's technique[10], using as source of thromboplastin either 6 per cent human or 3 per cent rabbit brain suspension and 0·01 *M* calcium chloride.

INFLUENCE OF —SH COMPOUNDS ON THE PROTHROMBIN TIME OF HUMAN OXALATED PLASMA

Plasma	Glutathione 10^{-2}	Cysteine 3×10^{-2}	*BAL*		Control plasma plus phosphate buffer
			7×10^{-3}	$2{\cdot}9 \times 10^{-3}$	
1	16	21	34	—	12·5
2	18	25	44	—	12·5
3	19	26	35	—	12·5
4	29	—	—	23	17·5
5	19	—	—	18	13·5
6	19	—	—	19	13·5

The concentrations are given in equivalents of —SH, and the clotting times in seconds

A comparison of the efficacy of *BAL* and cysteine was carried out and the results tabulated on the accompanying graph.



PROTHROMBIN INACTIVATION BY *BAL* AND CYSTEINE. EACH POINT ON THE CURVE REPRESENTS THE AVERAGE VALUE OF THREE DIFFERENT SPECIMENS OF HUMAN OXALATED PLASMA. FROM THE CURVE IT IS APPARENT THAT *BAL* WAS FIVE TO EIGHT TIMES MORE ACTIVE THAN CYSTEINE

It was found that *BAL* had no effect on thromboplastin prepared from rabbit's brain when incubated for varying periods up to 16 min. at 37·5° C. Further, very little alteration of the coagulability of purified fibrinogen was observed when coagulation was carried out by thrombin. The fibrinogen was prepared from human oxalated plasma according to the technique of Jaques[11]. The —SH compounds were added to give a final concentration of 10^{-2} in respect of —SH groups. The clotting time of the fibrinogen stock solution was 21 sec. throughout the period of observation, and the highest value found for the experimental mixtures was 24 sec. When oxalated plasma was used instead of purified fibrinogen, no change in the coagulation time was observed when clotting occurred by the addition of thrombin, whereas a similar —SH concentration ($1{\cdot}4 \times 10^{-3}$) had a marked effect on the prothrombin time. The influence of *BAL* on thrombin was tested by incubating it with thrombin prepared from human oxalated plasma by Eagle's technique[12]. The thrombin solutions were diluted to give convenient clotting times when tested on oxalated plasma, which served as a source of fibrinogen in these tests. A similar ionic strength as well as *p*H was employed. It was observed that thrombin required a considerably higher concentration of the —SH compound even for partial inactivation.

Most of the enzymatic reactions involved in carbohydrate fat and protein metabolism require —SH groups for their activity[13]. From the group of physiologically active substances, insulin appears to be an exception, since it is inactivated by —SH compounds. It has been found that *BAL* combines with arsenicals and metals to form non-toxic cyclic compounds, and it is a strong reducing agent. It also inactivates insulin, possibly by the destruction of the —S—S— groups[14]. *BAL* is more powerful in its detoxicating activities than mono —SH compounds. A comparison of the efficacy of —SH compounds made by Long and Farah[5] in dogs indicated that *BAL* is five to eight times more potent than glutathione or cysteine in protective action against 'Salyrgan'. It is interesting to note that a similar superiority of *BAL* has been observed in prothrombin inactivation. There is no evidence that metal ions except calcium play any part in coagulation, or are part of the prothrombin molecule. It would seem that the inactivation of prothrombin by *BAL* is due to its ability to attack the active centre in the prothrombin molecule, possibly by converting —S—S— groups to —SH radicals.

The action of *BAL* on thrombin is of a different nature. The —SH concentration required to reduce thrombin activity is thirty to forty times greater than that which inactivates prothrombin to a similar extent. In view of the fact that the conversion of fibrinogen to fibrin by thrombin is inhibited by many compounds, including neutral salts, when used in concentrations comparable to those employed in this study, the effect cannot necessarily be considered specific.

The dosage for the treatment of metal poisoning is given as 4–5 mgm. *BAL*/kgm. body-weight. Using a 10 per cent solution in peanut oil, rabbits were injected intramuscularly with 5–7 mgm. *BAL*/kgm. body-weight.

No change in whole blood coagulation time or prothrombin activity could be detected when plasma samples were taken one and two and a half hours after the injection.

Although the effect of *BAL* on coagulation *in vitro* is pronounced, it does not appear likely that this substance will produce hæmorrhagic tendencies *in vivo*.

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* Working under a full-time grant from the National Health and Medical Research Council.

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Fibrinolytic Activity of Normal Urine

It has been established that human plasma contains an active fibrinolytic and proteolytic enzyme (plasmin), its inactive precursor (plasminogen), and also an inhibitor (antiplasmin) that normally overneutralizes the enzyme[1,2]. Plasmin and plasminogen are associated with the globulin fraction, antiplasmin with the albumin. Fibrinolytic activity can be induced in plasma by the addition of chloroform, which destroys antiplasmin, or of streptokinase, which activates plasminogen. Activity also occurs spontaneously in human subjects who have suffered surgical operation[3], trauma, fear[4], strenuous exercise, or the injection of adrenalin[5].

The last of these observations revealed the fact that the activity induced by these means disappeared from the circulating blood within a few minutes of the cessation of the stimulus, suggesting that plasmin is rapidly inactivated or eliminated. Among other possibilities its excretion by the kidney was considered, and the consequent examination of the urine by methods already described for plasma fractions[2] has, in fact, demonstrated considerable fibrinolytic activity in all samples examined. This activity existed even when no stimulus had been applied, and though it varied in intensity in the same subject from time to time, and from one subject to another, it was, on the average, four or five times greater than that of active plasmin, complete lysis of fibrin being produced within 24 hours by urine diluted 1/2,000–1/4,000. Though this titre increased considerably after exercise, the amount of urine passed was so much less as compared with control periods of rest that the total active principle excreted was not significantly greater than normal, and it seems improbable that the post-exercise fall in blood-plasmin can be explained by its simple elimination by the kidney.

Nevertheless, in some respects the fibrinolytic agent of urine resembles plasmin. It is not diffusable, being retained by 'Cellophane'. It is precipitated by 50 per cent saturation with ammonium sulphate, full saturation with sodium sulphate, or by bringing the *p*H of the urine to 5·5 after removing all electrolyte by dialysis. It is also precipitated by 50 per cent alcohol or acetone. It will digest fibrinogen, fibrin, albumin and casein, as judged by estimation of acid soluble tyrosine. The *p*H of optimum activity is 7·4, and of maximum heat stability 6·8, these being very close to the corresponding figures for plasmin.

There are, however, points of difference. The urine factor is less heat-labile than plasmin, 5 per cent activity remaining after 30 min. at 80° C., but it is totally destroyed by boiling. The urine factor is inhibited by antiplasmin and soya-bean trypsin inhibitor, and this inhibition is relatively more effective per unit of activity than is the case with plasmin. Plasmin is very strongly adsorbed by fibrin; the urine factor less so.

It is not certain at present, therefore, what relationship the proteolytic enzyme of the plasma bears to the rather similar factor present in the urine. Neither the points of similarity nor of difference are conclusive evidence for or against the two being identical. However, the existence of such an activity of urine is itself of some interest.

Previous observations on the proteolytic activity of urine are few. Loeper and Baumann[6] studied the excretion of 'pepsin' in the urine of normal and pathological subjects, and there is a recent paper on the urinary content of a similar enzyme, with a review of other references, by Farnsworth, Speer and Alt[7]. In view of the clear-cut differences between the properties of pepsin and those of the agent described here, this previous work probably has little bearing on the present observations.

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Use of Trypsin in the Detection of Incomplete Anti-*Rh* Antibodies

In an attempt to define the properties of the enzyme present in the filtrate of a culture of vibrio cholera, which causes cells sensitized with an 'incomplete' anti-*Rh* antibody to agglutinate[1], cultures of other organisms and pure enzyme preparations have been tested. During this investigation trypsin has been found to cause agglutination of cells sensitized with an 'incomplete' antibody, and also to enhance the specific agglutination of other hæmagglutinins in the absence of any detectable antibody of the 'incomplete' type.

If trypsin is added to the serum or to the cell antigen antibody mixture, its action may be inhibited by the natural trypsin inhibitor present in all sera[2]. This can be overcome by the addition of an excess of the enzyme or removal of the serum inhibitor, or by washing cells already sensitized before exposing them to the trypsin; if this latter method is used, a single washing is sufficient to remove the inhibitor. Test cells may also be incubated with trypsin and, on incubation with sera, show enhancement of agglutination with *iso*agglutinins and immune agglutinins, and agglutination with sera of the 'incomplete' type; and after such treatment are not susceptible to the normal serum inhibitor or to soya bean trypsin inhibitor. With fresh undiluted sera, however, there is also enhancement of rouleau formation, which can be abolished by the addition of saline.

In this investigation the trypsin preparations used have been crystalline trypsin (Plaut Research Laboratory, New Jersey) and *liquor trypsini co.* (Allen and Hanbury). The stock solution of crystalline trypsin has been a 1 per cent solution in $N/20$ hydrochloric acid, and has remained stable for three months. Before use the stock solution is diluted with phosphate buffer (*p*H 7·2) to a concentration of 1 : 400 to 1 : 10,000; and the *liquor trypsini co.* is diluted with buffer to give a final concentration of 1 : 5 of the original solution. With a 1 : 400 solution of crystalline trypsin, complete agglutination of fully sensitized cells occurs within 20 min. With increasing dilution of the enzyme the time of agglutination is lengthened.

As with the enzyme present in the filtrate of vibrio cholera, trypsin appears to act on the surface of the red cell but does not affect any of the known hæmagglutinogen loci. Neither removal of the normal trypsin inhibitor from an 'incomplete' serum nor the incubation of inhibitor-free serum with trypsin for up to 30 hr. has changed the type of reaction of the sera from the 'incomplete' to the agglutinating form. After incubation the sera still show the blocking reaction[3], though the 'Coombs'' test[4] is markedly weakened.

In the detection of incomplete anti-*Rh* antibodies some of the reagents are difficult to obtain or the methods are laborious for routine use. The trypsin method is very simple in execution and only requires a standard pharmaceutical preparation as a reagent. The crystalline trypsin solutions have given positive results in parallel with the Coombs' test with twenty incomplete anti-*D* sera and also with cells sensitized *in vivo* in infants suffering from hæmolytic disease of the newborn.

The full results of these findings, together with considerations of the part they play in agglutination and in the elucidation of the nature of the incomplete antibody, will be published later. We are indebted to Dr. Kunitz for the soya bean trypsin inhibitor and to Dr. A. H. T. Robb-Smith and Dr. R. G. Macfarlane for much help and advice.

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Succinoxidase Activity of Hepatic Tumours Produced in Rats by Feeding 2-Acetaminofluorene

THE succinoxidase content of experimental tumours of various origins, as well as of spontaneous tumours, has been found to be low[1-6]. In agreement with these findings in experiments conducted here, a low succinoxidase activity was found in hepatic tumours produced by feeding *p*-dimethylaminoazobenzene[7]. In a series of experiments, however, the completion of which has been delayed for technical reasons, it was observed that hepatic tumours produced by feeding 2-acetaminofluorene have an exceptional position in so far that the succinoxidase content of these tumours is about the same as, or but very slightly lower than, that of livers from normal rats on the same diet without the carcinogenic compound.

The experiments were carried out on piebald and albino rats weighing about 100 gm. at the beginning of the experiment. They received a diet containing 13 per cent of its caloric value as protein and 30 per cent as fat and 2-acetaminofluorene in a final concentration of 0·07 per cent. The succinoxidase activity was estimated in the Warburg apparatus, in both slices and homogenates. The results obtained are summarized below, the values given being means from six animals; the ranges follow in brackets.

For homogenates in the presence of sodium succinate, oxygen uptake (c.mm.) per 1 mgm. initial dry weight per hour without added cytochrome C was: (*a*) control livers, 15·6 (9·5–19·5); (*b*) liver tissue of animals bearing hepatic tumours, 16·4 (13·8–18·7); (*c*) tumour tissue, 14·9 (9·8–21·8). The succinoxidase activity in the presence of excess cytochrome C was: (*a*) 27·9 (16·2–48·0); (*b*) 30·3 (18·8–44·5); (*c*) 25·2 (13·8–43·8).

For slices the corresponding values for succinoxidase activity per 1 mgm. final dry weight were: (*a*) 38·4 (35·3–45·0); (*b*) 32·6 (28·0–36·7); (*c*) 27·4 (20·3–39·4). The oxygen uptake of the slices without addition of a donor were: (*a*) 9·4 (7·0–11·3); (*b*) 10·1 (8·8–11·3); (*c*) 9·2 (4·5–12·5).

Histologically the tumours were solid hepatomas, but each liver contained a small number of cystic and non-cystic cholangiomas. The tumours were multifocal, and metastases in the regional lymph glands and in the lungs were found. The tissue referred to as 'liver' (*b*) showed on microscopical examination usually small nests of neoplastic tissue. Nevertheless, no difference could be established in the oxidative capacity of these livers and normal livers from rats on the same diet without addition of the carcinogen.

The present experiment demonstrates that tumours from a matrix of high succinoxidase activity can retain this capacity in spite of their obvious malignancy.

I wish to express my gratitude to the Sir Halley Stewart Trust for a fellowship held during this work; my thanks are due also to the British Empire Cancer Campaign, the Anna Fuller Fund and the Jane Coffin Childs Memorial Fund for grants made towards the support of the work carried out in the Chester Beatty Research Institute.

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Enzymic Modification of the Reaction Between Influenza Virus and Susceptible Tissue Cells

THE enzyme of *V. choleræ* which destroys the capacity of red cells to agglutinate with viruses of the influenza group[1] closely parallels these viruses in many aspects of its action on the red cell surface[2]. Investigations were, therefore, made to determine whether this receptor-destroying enzyme could alter the reactivity of tissue cells normally susceptible to infection with influenza virus.

Experiments, similar to those of Hirst[3], dealing with the interaction of virus hæmagglutinin and the tissue cell will be reported first. Hirst has found that the cells of the perfused, excised ferret lung rapidly adsorb influenza virus hæmagglutinin, and after a short period spontaneously release it in essentially the same way as do red cells. In the present work, the behaviour of virus hæmagglutinin was studied in the allantoic cavity of the chick embryo using eggs previously treated with the receptor-destroying enzyme as well as untreated eggs. Formalin, sufficient to kill the embryo within two hours, was administered together with the virus.

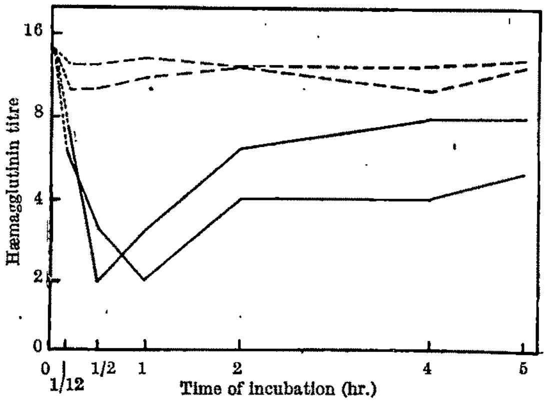

Fig. 1. GRAPH OF VIRUS HÆMAGGLUTININ TITRE IN THE ALLANTOIC CAVITY OF FORMALINIZED EGGS FOLLOWING PRE-TREATMENT WITH ACTIVE AGAR FILTRATE (RECEPTOR-DESTROYING ENZYME) (DUPLICATE EGGS) – – – – – ; BOILED AGAR FILTRATE (DUPLICATE EGGS) ———. TITRE OF VIRUS DILUTION INJECTED = 14

The allantoic cavity of a 13-day old embryo was drained, refilled with 5 ml. of saline containing the receptor-destroying enzyme, and the egg slowly rotated for 30 min. at 35° C. in a mechanical device. The fluid was again removed, and a further 5 ml. of saline containing 0·5 per cent formalin and approximately twenty agglutinating doses of swine influenza virus were injected. Samples of fluid taken at intervals over a period of four to five hours at 35° C. were titrated for hæmagglutinin content in the presence of 1 per cent sodium citrate at 4° C. in order to minimize destruction of the receptors of the indicator red cells by residual receptor-destroying enzyme. Control eggs received an initial treatment with saline or with the enzyme inactivated by boiling.

Fig. 1 expresses graphically the results of an experiment in which eggs were treated with a 1 : 10 dilution of crude receptor-destroying enzyme in the form of a Seitz filtrate prepared from soft agar cultures of *V. choleræ* and heated at 55° C. for 40 min. in the presence of excess calcium chloride[4]. Essentially similar results were obtained using the enzyme purified by elution from red cells[4], while the graphs for the eggs receiving boiled agar filtrate are similar to those of eggs receiving pre-treatment with saline only. It will be seen that in the control eggs there is rapid adsorption of virus followed by liberation after a period of three to four hours. Pre-treatment with the receptor-destroying enzyme prevents this adsorption.

Following this evidence of interference with adsorption of virus hæmagglutinin on the susceptible cell, attempts were made to prevent the onset of infection in the allantoic cavity of living chick embryos. The receptor-destroying enzyme was administered 30 min. prior to inoculation with swine influenza virus. As evidenced by the experiment illustrated in Fig. 2, administration of 0·5 ml. of agar culture filtrate brought about a highly significant reduction in the percentage of infections, whereas embryos receiving boiled agar filtrate reacted in the same way as did normal embryos. Tests with the enzyme eluted from red cells gave similar results.

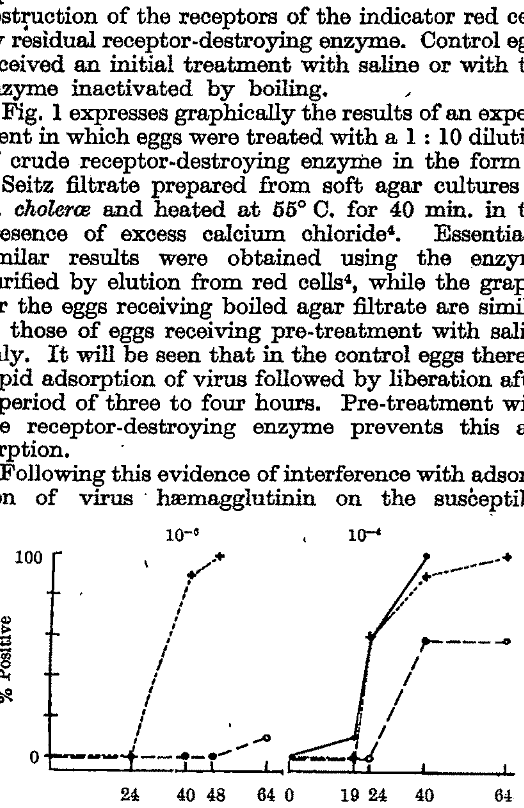

Fig. 2. EFFECT OF RECEPTOR-DESTROYING ENZYME ON INFECTION IN THE ALLANTOIC CAVITY WITH VIRUS 10^{-6} (TEN 50 PER CENT INFECTIVE DOSES) AND 10^{-4}. THE PERCENTAGE OF SURVIVING EMBRYOS GIVING POSITIVE HÆMAGGLUTINATION IS SHOWN FOR EGGS RECEIVING A PRIOR INJECTION OF ACTIVE AGAR FILTRATE (RECEPTOR-DESTROYING ENZYME) - - - - - - - ; BOILED AGAR FILTRATE ——— ; SALINE ......

These experiments, which are being continued and will be more fully reported elsewhere, lend support to Hirst's hypothesis[3] that enzymic destruction of a specific receptor substance may be a necessary step in the process of cellular infection by influenza virus. In addition, they provide further justification for the use of the red cell as a model in the study of the reaction between virus and the susceptible tissue cell.

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Pulmonary Œdema and the Spleen

WHILE investigating the pharmacological properties of 2-thio-5-methyl-uracil (thio-thymine), it was noticed that this compound could be given intramuscularly to splenectomized rabbits in a dosage of 100 mgm./kgm. without ill effect, but that a similar dosage when given to normal rabbits invariably produced death from pulmonary œdema; thus, with normal rabbits, 6/6 dead in 5 days; with splenectomized rabbits, 0/6 dead after two months, and similar rabbits sacrificed two–three days after injection showed no macroscopic or microscopic signs of pulmonary œdema.

It is well known that other anti-thyroid agents (for example, phenylthiourea, thiourea and thiouracil[1,2,3]) in acutely toxic doses cause a rapidly fatal pulmonary œdema, but the fact that the spleen is necessary for the production of this œdema has not previously been noted in the literature.

The phenomenon was further investigated by making acid-aqueous (1–3 per cent acetic acid) extracts of hog and beast spleens, suspending 1 gm. thio-thymine in each 10 c.c. of the filtered extracts for six hours at 37° C., and then injecting intramuscularly the thio-thymine-splenic extract mixture (in a dosage corresponding to 100 mgm./kgm. thio-thymine) into splenectomized rabbits. These rabbits all (3/3) died from massive pulmonary œdema. The splenic extracts alone when injected into normal or splenectomized rabbits produced no obvious effects.

Further, the aqueous splenic extracts were precipitated with 7 volumes of 70 per cent alcohol, filtered, the filtrate vacuum-dried and the dried powder redissolved in water. Thio-thymine was then suspended (1 gm. per 10 c.c.) in this deproteinized splenic extract for six hours at 37° C. and the mixture finally injected intramuscularly into splenectomized rabbits, in a dosage corresponding to 100 mgm./kgm. thio-thymine. Again, all the rabbits (3/3) died with pulmonary œdema, whereas the deproteinized extracts alone were without effect when injected into control normal and splenectomized rabbits.

The dried precipitate from the alcoholic precipitation of the splenic extracts was next dissolved in water and mixed with thio-thymine at 37° C. for six hours. The mixture was then injected as before into splenectomized rabbits. 1/3 rabbits died from pulmonary œdema: the precipitate alone had no effect when injected into a control group of rabbits.

Landgrebe and Morgan[4] have noted that non-fatal doses of thiourea and thiouracil protect rats from a subsequent normally lethal dosage of thiourea. We have observed a similar effect here, in that splenectomized rabbits which have survived injection of thio-thymine do not succumb to, or show any evidence of, pulmonary œdema after injection of the thio-thymine-splenic extract mixtures.

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March 17.

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[1] MacKenzie, C. S., and MacKenzie, J. B., *Proc. Soc. Exp. Biol. and Med.*, **54**, 34 (1943).

[2] Meyer, A. E., Collins, M. B., and Marine, D., *Proc. Soc. Exp. Biol. and Med.*, **55**, 221 (1944).

[3] Richter, P. P., and Cesby, K. H., *Arch. Path.*, **33**, 46 (1942).

[4] Landgrebe, F. D., and Morgan, T. N., *Nature*, **157**, 23 (1946).

Cultivation of Rabies Virus *in vitro*

I HAVE reported[1] that rabies virus can multiply *in vitro* in a cell-free medium containing steamed sheep-brain extract, sheep serum, glycine and peptone. The effect of the addition of certain amino-acids and accessory factors on the growth of the virus in this medium has been investigated.

Addition of tryptophan in a concentration of 2 mgm. per 100 ml. of the medium showed a stimulating effect on the growth of the virus, the concentration obtained in cultures containing tryptophan being 25 million M.L.D. per ml. as against 10 million M.L.D. per ml. obtained without it. Higher concentrations of tryptophan up to 20 mgm. per 100 ml. of the medium did not yield better results.

The effect of the addition of thiamine hydrochloride, pyridoxine hydrochloride, calcium pantothenate, nicotinic acid, riboflavin and biotin was investigated. All these accessory factors, excepting biotin, were added in a concentration of 2 μgm. per ml. of the medium. The sample of biotin available (its exact potency was not known) was diluted 1 in 10, and 0·2 ml. added per 100 ml. of the medium. The effect of these factors when added to the cultures individually and collectively was investigated.

Concentrations of virus obtained in cultures containing biotin was 100 million, with thiamine hydrochloride 75 million, with pyridoxine hydrochloride 75 million, with calcium pantothenate 75 million, with nicotinic acid 50 million and with riboflavin 50 million M.L.D. per ml. The initial concentration of virus in cultures before incubation was 50,000 M.L.D. per ml. These findings would appear to show that each of the factors tested had marked growth-promoting properties, and that biotin, thiamine hydrochloride, pyridoxine hydrochloride and calcium pantothenate were the most effective.

With the addition of tryptophan, plus all the above factors, it was possible to dispense with the use of steamed sheep-brain extract. Concentrations as high as 5,000 million M.L.D. per ml. were obtained with a medium containing 2·5 per cent glycine, 2 per cent sheep serum, 0·15 per cent peptone, 2 mgm. per cent tryptophan, 2 μgm. per ml. of each of thiamine hydrochloride, pyridoxine hydrochloride, calcium pantothenate, nicotinic acid and riboflavin, together with 0·2 ml. per 100 ml. of biotin solution. This represents about 3,000 times the concentration of virus ordinarily obtained in the brains of infected sheep used in the manufacture of antirabic vaccine.

Comparative tests carried out under aerobic, partially anaerobic and strict anaerobic conditions showed that the concentration of virus obtained in cultures incubated under strict anaerobic conditions was higher than that obtained when cultures were incubated under aerobic or partially anaerobic conditions.

Attempts were made to cultivate rabies virus in a cell-free medium containing 5 per cent glycine, 0·3 per cent peptone and 4 per cent sheep serum in distilled water. The virus inoculum consisted of the filtrate obtained by passing through a Sterimat F.C.B. pad the supernatant liquid from a centrifugalized 20 per cent suspension of fixed virus sheep brain. This was done in order to eliminate the possibility that the 'seed' might contain intact cells which may be responsible for the multiplication of the virus. One part of the virus inoculum was added to one part of the above medium, so that the final concentration of the various constituents was the same as that employed in previous experiments. The proportion of tryptophan and the other accessory factors was kept constant. The virus content of the culture before incubation was 100,000 M.L.D. per ml. After 24 hours incubation under anaerobic conditions, it increased to 2,500 million M.L.D. per ml.

It was also found possible to subculture the virus *in vitro* in this medium, provided 20 per cent steamed normal sheep-brain extract was added to it in quantities equal to the virus inoculum used as the 'seed'.

Successful cultivation of the etiological agent of rabies in a cell-free medium indicates that it is not a virus in the accepted sense of the term. This finding lends further support to earlier evidence I have obtained[2] that an agent other than a virus may be connected with the etiology of rabies.

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April 1.

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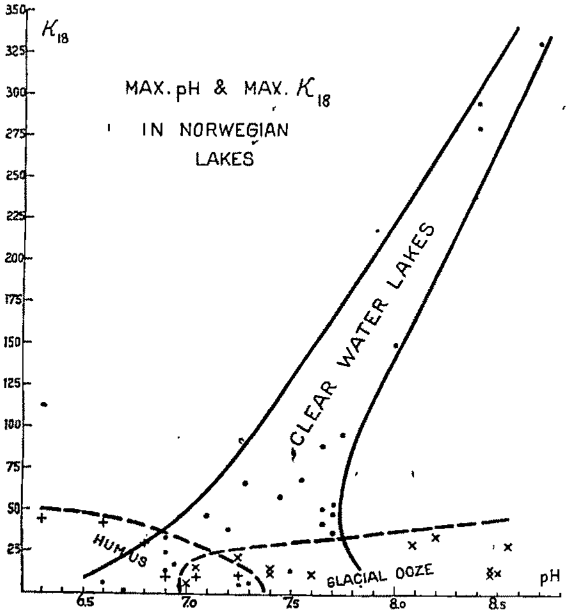
[1] Veeraraghavan, N., *Ind. J. Med. Res.*, **34**, 207 (1946).

[2] Veeraraghavan, N., *Ind. J. Med. Res.*, **32**, 207 (1944); **33**, 285 (1945).

Correlation Between $\varkappa_{18}$ and *p*H in Lakes

THERE is a definite relation between specific conductivity ($\varkappa_{18} = n \times 10^{-6}$) and active reaction (expressed as *p*H, and indicating the concentration of hydroxonium (H_3O^+) ions) in lake waters. Within a single lake these values vary inversely, which really means that the concentrations of electrolytes and H_3O^+-ions move together. Biological processes deplete surface waters of carbon dioxide and dissolved salts. There is a corresponding increase in the deep, where dead organisms sinking down from the fertile, sunlit surface ('trophogenic' zone) disintegrate in the bottom waters ('tropholytic' zone). From lake to lake there is, however, a positive correlation between *p*H and $\varkappa_{18}$.



On the diagram are plotted a large number of data from various lakes in Norway, each point representing one lake. The observations are of the maxima found in each lake, irrespective of the time when the observation was made, or the depth from which the sample was collected. Thus a κ_{18}-value from the deep in autumn may be paired with a pH from surface waters in early summer. Clear-water lakes are indicated by dots; humic waters by crosses; glacial waters by crosses. From several lakes there are series from all depths, extending over one year. The lines of delimitation only refer to the data actually in the diagram, and with additional observations will certainly have to be re-drawn.

The correlation is a close one in all clear-water lakes, especially as soon as there is present an appreciable amount of electrolytes acting as buffers. Only with very low salt concentrations is there a wider range in pH, as a little free carbonic acid then suffices to change the reaction appreciably.

Very different are the brown water lakes, where stronger acids may cause a low pH, even when there is a relatively high concentration of electrolytes.

Lakes with suspended ooze from glacial melt-water frequently have a disproportionately high pH.

This may be due to an adsorption of hydroxonium ions to clay particles of colloidal size, perhaps also to alkali dissolved from freshly ground rock particles.

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Vernalization of Excised Mustard Embryo

In contrast to vernalized wheat and rye, vernalized unsplit mustard seed does not become devernalized under high temperature[1]. Experiments were undertaken with mustard *T*.102 to find out whether (i) embryos excised from dried vernalized unsplit seeds would produce vernalized plants; and (ii) whether the effects of chilling excised embryos of mustard in different media would be similar to those observed by Gregory and Purvis[2] and Purvis[3] with embryos of winter rye.

Embryos excised from control- and vernalized unsplit seeds of mustard *T*.102 (dried and stored at room temperature for thirteen months) were thoroughly washed in glass-distilled water and were sown in pots on April 14, 1946. Control and vernalized whole seeds were also sown on the same date. Plants from embryos showed longer vegetative periods than corresponding plants from whole seeds on account of the lack of cotyledonary leaves in embryo plants. Similar prolongation of the vegetative periods occurred in seedlings (alike control and vernalized) when the cotyledonary leaves were amputated soon after their emergence. Plants from vernalized seeds flowered 13·5 days earlier than plants from control seeds. Plants from embryos excised from dried vernalized seeds flowered 12·5 days earlier than plants from control embryos. This proves that the embryos of vernalized unsplit mustard seeds will retain the induced vernalization for more than a year at least.

In this experiment sterile glassware and solutions were employed, and instead of the usual agar slant in test tubes, small Petri dishes containing a layer of finely powdered 'Pyrex' glass were used for chilling excised mustard embryos. After thorough washing in glass-distilled water, thirty embryos were placed in each of the Petri dishes containing: (1) Purvis's[3] modification of White's nutrient solution plus 2 per cent sucrose; (2) nutrient solution only; and (3) glass-distilled water. Three similar sets of Petri dishes with thirty embryos each were put in the chilling cabinet (2°–4° C.) on appropriate dates so that embryos chilled in the different media for one, two and three weeks were ready for sowing in pots, containing finely sifted sterile garden soil, on April 27, 1946. Intact seeds were also chilled in the same cabinet for one, two and three weeks, and were also sown on the same date, along with control embryos, and seeds germinated at room temperature for three days. The observed number of days from sowing to the opening of the first flowers is given in the accompanying table.

AVERAGE VEGETATIVE PERIODS (DAYS) OF PLANTS FROM CONTROL AND VERNALIZED EMBRYOS AND SEEDS OF MUSTARD *T*.102. (1) NUTRIENT WITH 2 PER CENT SUCROSE; (2) NUTRIENT ONLY; (3) GLASS-DISTILLED WATER. NUMBER OF PLANTS GIVEN IN BRACKETS

	Embryos Veg. period	Earliness (per cent)	Seeds Veg. period	Earliness (per cent)
Control				
(1)	Embryos discarded on account of infection			
(2)	56·17±0·63 (17)			
(3)	56·15±1·01 (13)		41·10±1·35 (19)	
Chilled:				
One week				
(1)	42·70±1·23 (10)	24		
(2)	39·64±0·36 (25)	29		
(3)	40·75±0·52 (24)	25	34·13±1·07 (23)	17
Two weeks				
(1)	36·04±0·58 (23)	35		
(2)	37·34±0·68 (23)	33		
(3)	39·22±0·64 (22)	32	29·70±0·50 (17)	28
Three weeks				
(1)	36·56±0·72 (16)	35		
(2)	36·00±0·31 (12)	36		
(3)	36·76±0·58 (13)	35	27·00±0·54 (25)	34

From the table it will be seen that embryos chilled for different periods and in different media produced plants which flowered significantly earlier than plants from control embryos. Thus, like the endosperms of monocotyledons such as wheat and rye, the cotyledons of mustard seeds are not involved in the processes of vernalization. But unlike excised embryos of rye, which according to Gregory and Ropp[4] and Purvis[3] require addition of sucrose in the medium to induce maximum vernalization, mustard embryos can be maximally vernalized even in glass-distilled water. Purvis[3] has observed that excised embryo of rye, compared to the whole grain, requires longer duration of chilling to induce any acceleration of flowering. In the case of embryos of mustard *T*.102, however, the earliness in flowering (on percentage basis) induced by chilling for one and two weeks was greater in plants from embryos than plants from intact seeds.

A detailed report of this investigation, which is being financed by the Imperial Council of Agricultural Research, New Delhi, is being published elsewhere.

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[1] Sen, B., and Chakravarti, S. C., *Nature*, **157**, 266 (1946).

[2] Gregory, F. G., and Purvis, O. N., *Ann. Bot.*, **2**, 237 (1938).

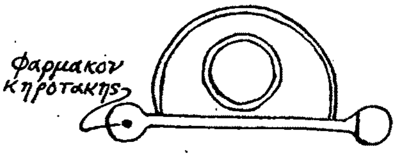
[3] Purvis, O. N., *Ann. Bot.*, **8**, 285 (1944).

[4] Gregory, F. G., and de Ropp, *Nature*, **142**, 481 (1938).

The *Kerotakis* Apparatus

Some interest has been taken in the summary of my Royal Institution lectures[1], and Dr. E. C. Stathis, of the University of Athens, has directed attention to a paper[2] by Prof. K. Zenghelis, of that University, on the *kerotakis* apparatus. Hoefer[3], who reproduced a diagram of it from a Paris manuscript[4], which[5] is copied from the old Venice manuscript[6], called it a '*bain-Marie à kérotakis*', explaining that it was not a water bath (as this name would suggest) but a sand- or ash-bath. The same name is used by Berthelot[7], who, however, gives a more adequate description of the apparatus, and in particular indicates that the name comes from that of the triangular palètte used by painters in encaustic for keeping liquid the wax pigments. He gives several pictures of the apparatus, which make it clear that there were several forms, probably destined for different uses. The one under consideration is that which I described[8] in 1929 as a small charcoal brazier, surmounted by a piece of apparatus the use of which is not immediately obvious, and in my lecture I stated that it was used for sublimation. The invention of this apparatus is attributed[9] to the early chemist Maria the Jewess (first century A.D.).

Prof. Zenghelis points out that, since the part of the apparatus above the hot plate is described as an inverted clay pot (φίαλη)[10] luted to the plate, the effects of heat on the materials inside could not be seen; and since the plate is shown in some representations[11] as projecting beyond the pot, he suggests that the ends served to support substances which by their fusion, evaporation or sublimation indicated the temperature inside the pot. Such a method of measuring temperature is still in use in the Seger cones put into pottery furnaces, and, it may be added, in preparations which change colour at definite temperatures and frequently appear in modern patents[12]. The *kerotakis* thus served as a kind of thermometer.



The correctness of this suggestion seems to be supported by a drawing which has not, so far as I am aware, been published. I give a sketch of this which I made in 1924 from a Paris manuscript[13]. It will be seen that there is a line joining the words φαρμακον κηροτακης [*sic*], that is, the materials Prof. Zenghelis thinks were used, with the edge of the plate, where he says they were placed.

There were, as I pointed out in my lecture, rival schools of chemists, the one whose teachings are mostly reproduced in the extant manuscripts being that of Demokritos. Another school seems to have followed Hermes. The commentator Olumpiodoros[14] quotes Agathodaimon as saying, from Hermes: "let it burn before the furnace (ἀπέναντι τῆς καμίνου) with the bark-like pieces of the red kobathia (κωβαθία) [= red arsenic sulphide, As_2S_2]. For the smoke of the kobathia, being white [= As_2O_3], whitens bodies [= metals such as copper]." This is the method used with such ill success by Neilos (see my lecture), who used a common fireplace instead of the refined *kerotakis* apparatus invented by Maria, of the rival school.

Interest in experiments and apparatus seems to have come into early chemistry from a Jewish source. It was foreign to Greek science; Aristoteles and Theophrastos were excellent at description, and in biology, which until recently was purely observational and descriptive, and hence their accounts seem so modern. They had little or no interest in experiment, and in Greek tradition apparatus was, apart from engines of war, almost entirely confined to toys, which reached a climax in the Byzantine period. To the two streams of Greek tradition, descriptive-biological treatment, and superstitious works such as the lapidaries and bestiaries, a third was added in the earliest chemistry, and this one, characterized by an interest in experiment and in the devising of apparatus, is uniformly ascribed to a Jewish source. Even if Wellmann's[15] thesis of an Essene origin is not accepted, his general theory seems to be plausible. I propose to develop this line of thought in detail elsewhere[16].

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[1] *Nature*, **159**, 81 (1947).

[2] Πρακτικὰ τῆς Ἀκαδημίας Ἀθηνῶν, 5, 127 (1930); I have used a reprint kindly sent by Dr. Stathis.

[3] "Histoire de la Chimie", 1, 284 (Paris, 1866).

[4] *BN* 2249 grec.

[5] Berthelot, "Collection des anciens alchimistes grecs", **1**, 129 (Paris, 1887–88).

[6] Marcianus, 299, xii cent.

[7] *Op. cit.*, 148.

[8] "Everyday Chemistry", Fig. 65D, 68 (London, 1929); from *BN* 2325 grec, f. 84 (xiii cent.).

[9] Berthelot, *op. cit.*, **2**, 238; Zosimos quoting Agathodaimon.

[10] This name was also used in the manuscripts for a flask or phial, the latter being so labelled in the drawings.

[11] Marcianus 299, f. 196 = Berthelot, *op. cit.*, **1**, 148, Fig. 24; already in Hoefer, *op. cit.*, from Paris 2249, f.102*v* (not "fol. 2 verso", as he says).

[12] For example, I.G. Farben-Ind., French Pat. 922308 (1937); see Tyte, *Proc. Inst. Mech. Eng.*, **152**, 226 (1945).

[13] *BN* 2249, f.103.

[14] Berthelot, *op. cit.*, **2**, 84; for a collection of statements of Hermes in the chemical manuscripts, see Festugière, A. J., "La Révélation d'Hermès Trismégiste", **1**, 240f. (Paris, 1944).

[15] Wellmann, M., "Die Φυσικά des Bolos Demokritos und der Magier Anaxilaos aus Larissa", *Abhl. Preuss. Akad. Wiss., phil.-hist. Kl.*, 1921, No. iv; Festugière, *op. cit.*, p. 197, thinks the correct name is 'Bolos the Demokritan', and that he may be the same as Demokritos the alchemist; I think the latter is doubtful.

[16] The relation to the conjuring tricks described by Hippolytos and the Jewish Gnostic, Markos, will also be discussed. Most of the professional magicians of the period seem to have been Jews.

THE NEW POSITION OF THE FORESTRY COMMISSION

By Prof. E. P. STEBBING
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IN *Nature* of March 17, 1945, the work of the Forestry Commission during its first twenty-five years was considered. The twenty-sixth annual report, for the year ending September 30, 1945, marks the beginning of a new phase. The report deals with the operations carried out on a more or less much diminished scale which had appertained during the war years. The total area planted by the Commission to the end of September 1945 was 469,000 acres, the total area controlled being 1,364,000 acres. The interest of the report lies in the details given on the future forest policy of Britain. Within the last thirty-five years the country has, on two occasions, for a period of years been dependent mainly on its own supplies of timber, of which in normal times of peace some 10,000,000 tons were imported annually. The two wars caused great inroads to be made on the privately owned woods of the island, for these had to supply the main bulk of the country's requirements; and the fellings—50 million cubic feet—were much heavier during the Second World War than in the First. The new State forests, the oldest but twenty years old at the outbreak of war, could supply only pit wood, from thinnings made in the oldest of the Commission areas. According to old-time accepted thinning theories in Conifers, mainly of German origin, there would have been little or nothing to come from these young British woods of twenty-five years of age and less. But investigation and observation, coupled with practice, have already demonstrated what had been expected, that in the exceptional moist and equable climate of Britain, the growth of some of the exotic Conifers surpasses that of the Conifers of Western Europe; hence earlier thinning is possible, though present experience is insufficient to lay down a rule in the matter.

The report notes that the year was a period of transition in national affairs, and the same in the Commission itself. The Forestry Act of 1945, which received Royal assent in June, changed the constitutional status of the Commission, which had been established under the Forestry Act of 1919. The progression of the new forestry work, the War and the heavy fellings in the privately owned woods, necessitated some changes in policy and administration. Up to then, the Commission had been an independent body subject only to the Treasury, which held the purse strings. In February 1945, it was announced in the House of Commons that in future the Minister for Agriculture, England and Wales, and the Secretary of State for Scotland would be responsible for forestry and forest policy in Great Britain, the Forestry Commission being retained as an advisory body with executive functions. Closer relations were to be made between the Agricultural Departments and the Commission. In practice this means that the officers serving in the Forestry Commission, of all categories, now form one of the Service Departments of the State for which a Cabinet Minister is responsible, and that forestry matters cropping up in the House of Commons will now have a Minister instead of a private member of the House, as before, to reply for and back up the forest policy already laid down. Ten Commissioners are to be maintained, and they are required to appoint committees for England, Scotland and Wales respectively, consisting partly of commissioners and their officers and partly of other persons. The commissioners will, in the words of the report, "devolve on these Committees such functions as they think fit". The new arrangement will undoubtedly make for forestry progress—the danger is that the latter will be clogged by the redundancy of committees and sub-committees which appear to be springing up all over Britain. It is difficult to foresee how these will make for either efficiency or rapidity of work, both of which are eminently desirable: the more so that the newly sanctioned forestry programme envisages the afforestation or replanting of 365,000 acres at a cost to the State of £20,000,000 spread over five years—a piece of work which will be watched with eagerness and will necessitate some rapid moving.

One outcome of the new trend given to the forest policy question in Britain is to be found in the much discussed 'Dedication of Woodlands' scheme, which in its first enunciation appeared to place all privately owned woodlands under the Forestry Commission. The first proposals were modified. The purpose of the scheme is to encourage correct management in private woods. This step is said to have become necessary in the interests of national security, because the reserves of standing timber were again greatly depleted during the War, and also because the area of land suitable and available for timber production in Great Britain is limited. The first of these contentions appears to ignore the fact that, however badly British privately owned woodlands may have been managed in the past, they did provide nearly 50 million cubic feet of timber for the War, for the growth of which the State, that is, the ordinary public, had paid nothing. But the very fact that so large a proportion of the woods of the country have been swept away makes their replacement a matter of the first importance, especially as the acres they occupied contain forest soils, a valuable planting asset which is absent on the large tracts of bare land which the Commission is engaged in afforesting. The principles underlying the scheme are: "(1) That the rehabilitation of Woodlands must proceed with both certainty and rapidity. (2) That all planting, and natural regeneration acceptable instead of replanting, must be properly looked after up to the stage of satisfactory establishment. (3) In every case the Owner must make an early decision as to whether he is prepared to proceed with the work of rehabilitation. (4) If an Owner is so prepared and can give satisfactory assurances, he is deserving of financial assistance from the State. (5) When no satisfactory assurances are forthcoming within a stated period, the State should acquire the land. (6) That the wartime system of felling licences must continue until the reserves of standing timber can be adjudged satisfactory. (7) That some degree of control of the Sylviculture of private woodlands is necessary."

The basis of the scheme, in which the State undertakes to provide certain financial assistance, is that all woodlands in Britain judged to be suitable and necessary for timber production should either be dedicated to that purpose by the owner or acquired by the State. Dedication would run with the land and would be unaffected by changes of ownership. A covenant of dedication will be entered into by which both the State and the owner undertake the respective obligations agreed upon. The covenant would provide for arbitration in the event of disagreement.

NEW YORK ACADEMY OF MEDICINE

CENTENARY AWARDS

THE end of the centenary celebration of the New York Academy of Medicine (see *Nature*, April 12, p. 494) was marked by a Convocation Meeting held on April 24. The Medal of the Academy was awarded to Dr. James Alexander Miller, an authority on tuberculosis, who has been associated with the Academy for many years and in 1937 was its president. This medal was established in 1930 by Dr. Samuel McCullagh, to be awarded periodically to a distinguished medical scientist in recognition of outstanding service to humanity.

The following were elected honorary fellows of the Academy:

Dr. J. B. Collip, director of the Research Institute of Endocrinology of McGill University, known for his work on blood and tissue chemistry, who was largely responsible for the chemical isolation of insulin; Dr. Robert Debré, professor in the Paris Faculty of Medicine, author of outstanding works in the field of pediatrics and public health; Sir John Fraser, principal of the University of Edinburgh and regius professor of clinical surgery in the University; Dr. E. W. Goodpasture, professor of pathology and dean of the School of Medicine, Vanderbilt University, who has done outstanding work on virus diseases; Dr. Evert Gorter, professor of pediatrics, University of Ghent, known for his publications on the diseases of children; Prof. Einar Hammarsten, professor of pharmacology, Karolinska Institutet, Stockholm; Dr. A. V. Hill, Foulerton research professor of the Royal Society; Dr. G. M. Holmes, consulting physician to the National Hospital of Nervous Diseases, and president of the second International Neurological Congress; Dr. B. A. Houssay, president of the Argentine Society of Biology and of the Biological Section of the Argentine National Academy of Medicine, who has made valuable contributions to our knowledge of the hypophysis and pancreatic secretion; Sir William Wilson Jameson, chief medical officer of the Ministry of Health and Ministry of Education; Dr. Otto Loewi, known for work in the field of nerve physiology and on the chemical transmission of nerve impulses; Dr. T. Madsen, formerly director of the Laboratory of the State Serum Institute in Denmark, known for outstanding work on serology and epidemiology and public health; Dr. M. Martinez-Báez, head of the Institute of Tropical Diseases and professor in the School of Hygiene, National University of Mexico; Dr. L. A. Orbeli, director of the Pavlov Institute in Leningrad, known for his work on the physiology of the nervous system; Sir John Boyd Orr, director-general of the United Nations Food and Agriculture Organisation; Dr. A. N. Richards, chairman of the Committee on Medical Research, Office of Scientific Research and Development, whose work in recent years has dealt with the function of the kidney; Prof. J. A. Ryle, professor of social medicine and head of the Institute of Social Medicine, University of Oxford; Dr. René Sand, professor of social medicine, University of Brussels; Dr. H. E. Sigerist, director of the Institute of the History of Medicine, Johns Hopkins University, known for his work on the history of medicine; Dr. A. Stampar, rector and professor of public health and social medicine, University of Zagreb; Dr. A. Tiselius, professor of biochemistry, University of Uppsala, who has made outstanding contributions to our knowledge of biologically important substances, and their separation through the development of an apparatus for electrophoresis.

The following were elected corresponding fellows of the Academy:

Dr. C. H. Best, professor of physiology, University of Toronto, co-discoverer of insulin; Dr. E. Braun-Menéndez, physiologist connected with the Institute of Biology and Experimental Medicine in Buenos Aires; Dr. E. B. Chain, lecturer in chemical pathology, University of Oxford; Prof. H. R. Dean, professor of pathology, University of Cambridge; Dr. N. Hamilton Fairley, director of special research, Hospital for Tropical Diseases, London; Sir Alexander Fleming, professor of bacteriology, University of London, known for his work on bacteriology, immunology and chemotherapy, and on penicillin; Sir Howard Florey, professor of pathology, University of Oxford, known for his work on penicillin; Dr. C. Heymans, professor of pharmacology and director of the Institute of Pharmacology and Therapeutics of the University of Ghent, who has worked on the physiology and pharmacology of the cardiovascular and central and peripheral systems and of respiration; Dr. A. Lacassagne, associate director, Pasteur Laboratory, Institute of Radium, University of Paris; Dr. G. Liljestrand, professor of pharmacology and director of the Pharmacological Institute, Karolinska Institutet, Stockholm, known for his work on the physiology and pharmacology of respiration and the circulation; Dr. J. M. Mackintosh, dean and professor of public health, London School of Hygiene and Tropical Medicine, University of London; Dr. F. de P. Miranda, director of the National Institute of Nutrition of the Ministry of Public Health and Assistance, Mexico; Dr. A. L. v. Muralt, professor of physiology and director of the Hallerianum, University of Bern; Dr. J. V. J. Parisot, professor of hygiene and social medicine and director of the Regional Institute of Hygiene, Nancy; Dr. M. Ruiz-Castañeda, director of the Department of Medical Research, General Hospital, Mexico City, known for his work on typhus and Malta fever; Dr. A. v. Szent-Györgyi, director of the Institute of Biochemistry, University of Budapest; Sir Lionel Whitby, regius professor of physic, University of Cambridge, known for work on hæmatological and bacteriological subjects.

Awards were made as follows:

Bowen-Brooks Scholarships (eight awards of 500 dollars each). Because of changing conditions, they are being given for continued study in the United States of returning young medical men: William Henry, Joseph F. Hindman, Martin H. Orens, Maurice S. Raben, E. Lawrence Reichel, C. R. Southworth, Stanley Stellar, Joseph R. Wilder.

Louis Livingston Seaman Award, for aid in investigation in bacteriology or sanitary science: Dr. James M. Neill, Cornell University Medical College (1,000 dollars); Dr. Arnold W. Pratt, Cornell University Medical College (500 dollars); Dr. A. M. Pappenheimer, New York University College of Medicine (500 dollars); Dr. Samuel Prigal, New York City (500 dollars).

Edward N. Gibbs Memorial Prize, given by Mrs. Gibbs and Mrs. Charles Sherrill (daughter): Dr. Stanley E. Bradley, College of Physicians and Surgeons (1,500 dollars).

INTERNATIONAL UNION OF THEORETICAL AND APPLIED MECHANICS

AT the Sixth International Congress for Applied Mechanics, held at the Sorbonne in Paris, during September 22–28, 1946, the International Congress Committee, under the sponsorship of which these congresses are organised, decided to create a more permanent organisation, in order to provide the possibility of carrying out activities in the interval between the congresses and of entering into co-operation with other international scientific bodies. This permanent organisation adopted the name of "The International Union of Theoretical and Applied Mechanics". In agreement with the policy followed with respect to the international congresses for applied mechanics, the structure of the new Union thus far has been kept as simple as possible; a council has been elected, consisting at present of thirty members, and a secretary has been nominated for carrying out correspondence. The Council is the executive body of the Union; its members are persons actually engaged in scientific work (theoretical or experimental) in mechanics or in related sciences. The number of members of the same nationality must not in general exceed four; in certain cases a few extra members can form part of the Council, without being representatives of a particular country.

It is hoped that national organisations concerned with scientific work in applied mechanics and already in existence in various countries may be willing to enter into relationship with the International Union. The statutes of the latter have therefore been so framed that it will be possible to admit national organisations (or a national union of such, if there are more than one in the same country) as adhering organisations of the International Union. Any such national organisation (or union) can apply to have a representative on the Council. Organisations interested in co-operation with the International Union are invited to communicate with the representatives for their country.

Now that the draft statutes have obtained the required number of votes, the International Union is formally constituted. It will seek admission as an organisation adhering to the International Council of Scientific Unions.

Members of Council are at present: (*Belgium*): L. Baes (Brussels), F. H. van den Dungen (Brussels); (*Bulgaria*): K. Popoff (Sofia); (*China*): P. Y. Chou (Peiping), Y. H. Ku (Shanghai); (*Denmark*): J. Nielsen (Copenhagen); (*France*): A. Caquot (Paris), J. Pérès (Paris), H. Villat (Paris); (*Great Britain*): S. Goldstein (Manchester), R. V. Southwell (London), G. I. Taylor (Cambridge); (*Netherlands*): C. B. Biezeno (Delft), J. M. Burgers (Delft), C. Koning (Amsterdam); (*Norway*): J. Solberg (Oslo); (*Poland*): M. T. Huber (Gdańsk-Wrzeszcz); (*Sweden*): W. Weibull (Bofors); (*Switzerland*): J. Ackeret (Zurich), H. Favre (Zurich); (*Turkey*): Kerim Erim (Istanbul); (*United States*): H. L. Dryden (Washington, D.C.), J. C. Hunsaker (Cambridge, Mass.), Th. von Kármán (Pasadena, Cal.), S. P. Timoshenko (Palo Alto, Cal.); (*U.S.S.R.*): S. A. Christianovitch (Moscow), A. N. Kolmogoroff (Moscow), E. L. Nicolai (Leningrad). Extra members are: R. von Mises (Cambridge, Mass., U.S.A.); H. U. Sverdrup (La Jolla, Cal., U.S.A.).

The secretary for the present period is Prof. J. M. Burgers, van Houtenstraat 1, Delft, Holland.

It has been decided to accept the invitation of the Imperial College of Science and Technology, South Kensington, London, S.W.7, to hold the seventh International Congress for Applied Mechanics in its buildings during September 5–12, 1948.

THE EGYPTIAN ACADEMY OF SCIENCES

THE number of scientific workers in Egypt has increased considerably since the foundation of the Faculty of Science of the Fouad I University at Cairo in 1925. This has been accompanied by the development of a number of societies dealing with various branches of science, among which special mention may be made of the Société Entomologique d'Égypte, with its fine series of *Bulletins* and *Mémoires* dating from 1907. There has arisen also a demand for some institution where scientific specialists could meet and exchange ideas, for the famous Institut d'Égypte, founded by Napoleon, covers too wide a range of interests to meet these requirements. Accordingly, a group of nine Egyptians representing different branches of science met together in 1944 and founded an Egyptian Academy of Sciences, with Prof. Mohamed Khalil Bey as its secretary. The main objects of the new Academy are to stimulate a wider interest in science in general, and lead to more co-operation between men of science and a better co-ordination of their efforts.

The first volume of the *Proceedings* for 1945, published in 1946, has just been received, and comprises six articles dealing with biological subjects. All are written in English, but full abstracts in Arabic are included.

The first article, by the editor, Prof. K. Mansour, is devoted to an account of the Zooxanthellæ, and the food and feeding habits of the Tridacnidæ, in which the author attributes the large size reached by these lamellibranchs to their efficient feeding mechanism, and capacity of sieving huge quantities of water. The following article by Dr. J. J. Mansour-Bek deals with the digestive enzymes of *Tridacna elongata* and *Pinctada vulgaris*. In both papers the views of Prof. C. M. Yonge and others, as to the importance of intra-cellular digestion in these lamellibranchs, are strongly criticized. Prof. Y. S. Sabet describes the reaction of *Citrus mycorrhiza* to manurial treatment, and Z. Ahmed the effect of some environmental conditions on the growth and alkaloidal content of *Hyoscyamus muticus*. The nervous control of melanophores in the Egyptian chameleon is the subject of an interesting communication by Dr. A. M. Farghaly, and finally Dr. H. Said discusses the reaction of cotton, beans and other plants to colchicine treatment.

The difficulties attending publication in a foreign language have resulted in an unduly large number of printer's errors, but these do not affect the general standard of the *Proceedings*. Men of science in other countries will welcome the appearance of this publication and wish the new Academy every success. The *Proceedings* can be obtained either by exchange of corresponding publications, or by subscription (one Egyptian pound per annum). Communications should be addressed to the Hon. Secretary, Dar el Hikma, 42 Kasr Aini Street, Cairo, Egypt. E. HINDLE

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, June 9

University College, London (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Kapp: "The Presentation of Technical Information", Second Series, 2: "The Part Played by Psychology in Presentation".*

Tuesday, June 10

Medical Research Council (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. Robley D. Evans: "Applications of Radio-active Isotopes in Biological Research".*

Royal Anthropological Institute (joint meeting with the International African Institute, at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Dr. S. F. Nadel: "Shamanism in the Nuba Mountains".

Wednesday, June 11

Manchester Statistical Society (at the Reform Club, King Street, Manchester), at 5 p.m.—Annual General Meeting.

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. A. C. Healey and Dr. L. Ivanovszky: "Petroleum Products in the Printing Ink and Allied Industries".

Thursday, June 12

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. E. B. Verney, F.R.S.: "The Antidiuretic Hormone and the Factors which Determine its Release" (Croonian Lecture).

Friday, June 13

Institute of Economic Engineering (at Cowdray Hall, 1a Henrietta Place, London, W.1), at 7 p.m.—Mr. R. Cecil Smart: "Research and Expansion in Industry".

Sunday, June 8—Friday, June 13

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1).—Centenary Celebrations.

Saturday, June 14

Institute of Physics, Electronics Group (in the Fyvie Hall, The Polytechnic, 309 Regent Street, London, W.1), at 2.30 p.m.—Discussion on "Thermionic Emission from Oxide-Coated Cathodes" (to be opened by Dr. F. A. Vick, Mr. D. A. Wright and Mr. A. J. H. Darlaston).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Registrar—The Secretary, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7 (June 13).

Lecturer in the Engineering Department of the County Technical College, Wednesbury—The Director of Education, Dept. F.E., County Education Offices, Stafford (June 14).

Chief Metallurgist (temporary) to take charge of extensive chemical, metallurgical and testing laboratories at the Royal Ordnance Factory, Patricroft, near Manchester—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.388/47A (June 14).

Chemists (temporary) in the Department of Atomic Energy, Springfields Factory, Preston—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.389/47A (June 14).

Experimental Assistants (II and III, temporary) in the Department of Atomic Energy, Springfields Factory, Preston, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting F.390/47A (June 14).

Lecturer in Mathematics and Mechanics—The Principal, Willesden Technical College, Denzil Road, London, N.W.10 (June 14).

Lecturer in Philosophy in University College, Dundee—The Secretary, The University, St. Andrews (June 15).

Senior Lecturer, and a Lecturer, in Natural Philosophy—The Secretary, The University, Aberdeen (June 20).

Senior Assistant in the Mathematics Department, a Lecturer in Chemistry, and a Lecturer in Geology and Biology—The Principal, Derby Technical College, Normanton Road, Derby (June 21).

Lecturer and an Assistant Lecturer in Organic Chemistry, and a Lecturer and an Assistant Lecturer in Physical Chemistry—The Secretary, King's College, Strand, London, W.C.2 (June 21).

Lecturer in Engineering at Peterborough Technical College—The Chief Education Officer, Education Offices, Town Hall, Peterborough (June 21).

Chair of Psychiatry—The Secretary, The University, Edmund Street, Birmingham 3 (June 28).

Research Fellowship (Organic Chemist to conduct research in problems relating to child health)—The Secretary, Institute of Child Health, Hospital for Sick Children, Great Ormond Street, London, W.C.1 (June 30).

Principal Scientific Officers: (*a*) Physicist to lead and direct research in problems of heat transfer in and as the result of fires, and (*b*) Physical Chemist to take charge of work on various problems of combustion and the suppression of fire by chemical means—The Secretary, Civil Service Commission, 6 Burlington Gardens London, W.1, quoting No. 1911 (June 30).

Superintending Chemical Engineer in the Chemical Research and Development Department of the Ministry of Supply—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1902 (June 30).

Lecturer in Agriculture (Crop Husbandry), and an Assistant Lecturer in Agricultural Botany—The Registrar, University College of Wales, Aberystwyth (June 30).

Lecturer in Chemistry and Soil Science, at Trinidad—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (June 30).

Assistant Lecturer in Geology—The Registrar, University College, Cathays Park, Cardiff (June 30).

Head of the Pharmacy Department—The Principal, Heriot-Watt College, Edinburgh (June 30).

Deputy Government Chemist in Jamaica—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1 (June 30).

Assistant Lecturer, and Demonstrators (3), in the Department of Anatomy—The Registrar, University College of South Wales, Cathays Park, Cardiff (June 30).

Lecturer in Mechanical Engineering—The Registrar, Merchant Venturers' Technical College, Unity Street, Bristol 1 (June 30).

Principal of the new Technical College to be established at Grantham—The Director of Education, County Offices, Sleaford, Lincs. (June 30).

Lecturer (Grade II) and an Assistant Lecturer (Grade III) in the Department of Applied Mathematics—The Registrar, The University, Liverpool (July 1).

Senior Research Officer or Research Officer, Section of Meteorological Physics Research, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting No. 1291 (July 7).

University Lecturers and University Demonstrators in Engineering—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (July 7).

Henry Bell Wortley Chair of Metallurgy—The Registrar, The University, Liverpool (July 7).

Professor of Mathematics, a Professor of Physics, a Senior Lecturer in Mathematical Physics, and a Senior Lecturer in Physics, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 15).

Lecturer in Botany, a Lecturer in Zoology, a Lecturer in Chemistry, and an Assistant Lecturer in Mathematics, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 31 in New Zealand).

Fuel Engineer and Assistant Fuel Engineer (male) under the Ministry of Fuel and Power—The Director of Establishments, Ministry of Fuel and Power, 7 Millbank, London, S.W.1 (July 31).

Lecturer in Mechanical Engineering at the Chance Technical College—The Chief Education Officer, 215 High Street, Smethwick.

Science Lecturer in the Department of Bakery and Confectionery—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Crop Recorder, and an Assistant Seed Production Officer—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Registrar—The Principal, Huddersfield Technical College, Huddersfield.

Electronics Technician to undertake development, construction and maintenance work on electronic apparatus for medical use—The House Governor and Secretary, General Infirmary, Leeds.

Chemists (men and women) for temporary appointments in the Chemical Inspection Department, Ministry of Supply—The Ministry of Supply, Est. 5 (B) 2, Room 828, Adelphi, London, W.C.2, quoting Chem/65.

Graduate Research Assistant for experimental work on nuclear physics, mainly by cloud-chamber methods—The Professor of Physics, University College, Aberystwyth.

Lecturer (preferably recent Ph.D.) in field of nuclear physics, in the Department of Physics, Queen's University, Kingston, Canada—Principal R. C. Wallace, 15 Mays Hill Row, Shortlands, Bromley, Kent.

Laboratory Assistant (bacteriological, Grade B)—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Forestry Commission. Twenty-sixth Annual Report of the Forestry Commissioners for the Year ending September 30th, 1945. Pp. 52. (London: H.M. Stationery Office, 1946.) 9*d*. net. [91

Forestry Commission. Leaflet No. 4: The Black Pine Beetle (*Hylastes ater*) and other Closely Allied Beetles. Revised edition. Pp. 10. 2*d*. net. Leaflet No. 23: Pit-Props. Revised edition. Pp. 8. 2*d*. net. (London: H.M. Stationery Office, 1946.) [91

B.C.P.M.A. List of Members and Classified Index of Subjects. Pp. 44. (London: British Chemical Plant Manufacturers' Association, 1946.) [91

Communications of the Dublin Institute for Advanced Studies. Series A, No. 3: Developments in Quantum Electrodynamics. By Paul A. M. Dirac. Pp. 33. (Dublin: Dublin Institute for Advanced Studies, 1946.) 3*s*. [131

Anti-Locust Memoir 1: Seasonal Breeding and Migrations of the Desert Locust (*Schistocerca gregaria* Forskål) in Eastern Africa. By Z. Waloff. Pp. 76. (London: Anti-Locust Research Centre, British Museum (Natural History), 1946.) 8*s*. [131

National Institute of Economic and Social Research. Annual Report, 1945–6. Pp. 24. (London: National Institute of Economic and Social Research, 1946.) [131

The New Age of Atomics. (New Age Series, No. 2). Pp. 24. (London: Social Science Association, 1947.) 6*d*. [131

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SCIENCE AND THE HUMANITIES IN THE UNIVERSITIES

THE debate on university education in the House of Lords on May 14 was noteworthy for an important speech by the Lord Chancellor, Viscount Jowett, and for a contribution by Lord Cherwell which men of science should find of special interest. Lord Cherwell, in a cogent argument dealing with the dangers of central control of the universities, made a plea for the safeguarding of their autonomy in the increasing dependence of the universities on the Government for financial support; and he urged again the vital importance of not divorcing research from teaching, or teaching from work on the frontiers of knowledge. Speaking of the importance of the student having an opportunity of both studying the advance of knowledge and having it expounded and explained by those who were themselves working on the frontiers of knowledge, Lord Cherwell formulated admirably the function of a university teacher. This, as he sees it, is to develop in young people the habits of exact and logical thought, to show them how and where the underlying facts can be ascertained on which our conclusions are to be based, to indicate to them how the great minds of the past have tackled problems, to show what conclusions they have reached and how they have justified them; and, above all, to arouse the students' curiosity and interest and to stimulate them to spend laborious days and nights in an effort themselves to contribute something towards the advance of knowledge.

That is a fine ideal which must be kept in mind as we seek to formulate more specifically, as was urged in the recent British Association Conference held at Manchester (see *Nature*, May 24, p. 698), our ideas as to a general education for scientific workers. A further contribution to that end is to be found in a discussion of the relations between science and the humanities to which the greater part of the current issue of *The Universities Quarterly** is devoted. In that discussion, as in his speech in the House of Lords, Lord Beveridge makes a powerful plea that the social sciences should indeed be regarded as sciences and not as a branch of the humanities. They should be placed in their right relation to the other sciences, studied and taught not in isolation but together, and those who devote their lives to these studies should practise emotional detachment—above all from political controversies and the organisation of parties. This conviction leads Lord Beveridge to the view that the establishment of a science of human society should now have first call on all our resources and effort; and consequently such sciences should receive in full measure the material means they require for their development as sciences of observation and not as arts. This would in turn necessitate a manifold increase in the number of permanent posts in the faculties of social science of British universities, where teaching and research can be combined and where also the material means of research are available, especially statistical laboratories and provision for the training of field workers. As he did in the House of

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* Turnstile Press, 10 Great Turnstile, London, W.C.1.

Lords debate, Lord Beveridge here also suggested that the building up of the social sciences would make a valuable contribution towards preventing war and other misuses of natural science. He urged frankly that the leaders of natural science should favour the devotion of more money to social science, even if it meant less for natural science, and they should also realize that the social sciences are not the same as the natural sciences.

Sir Richard Livingstone discusses the need for a wider outlook in his contribution in *The Universities' Quarterly*. He recognizes it is necessary to see that both humanists and scientists, while specializing in their own subjects, at the same time receive the wider education which they need as men and citizens. Every educated man should understand the impact of science on civilization, and its place in civilization ; but the man of science also needs a wider education than science itself can give. What the world most needs to-day is a clear and worthy view of life. To this end Sir Richard suggests that moral philosophy should be a compulsory subject in universities, together with either logic or the theory of knowledge, and that it should be possible, but not compulsory, for everyone to take religion and the history of science in his or her degree course.

While Sir Richard Livingstone pleads for a return to the Greek attitude to life, Prof. J. D. Bernal, urging the establishment of closer relations between science and the humanities, suggests that we need an integration of the scientific and humanistic points of view, and that we should seek to join these two streams of human culture. He welcomes a plea put forward by Prof. Dobree for a common basis of knowledge, but he believes there would still be the need for faculties of arts and of science, differing in the emphasis given to different parts of the common basis. Prof. Bernal suggests that our presentation of whole subjects such as physics requires simplifying and should be accompanied by more interpenetration and also by active personal collaboration ; and he goes so far as to urge that the union of science and the humanities is a condition of survival.

Some of these ideas are to be found also in the fine presidential address "Classics and the Social Revolution of our Time" delivered by Lord Greene, the Master of the Rolls, to the Classical Association last April. Lord Greene urged that one of the principal allies in the defence of humanities is science itself. A race that knows and cares for nothing but science and its practical applications would, if left to itself, become as soulless and mechanical as the formulæ that it invents and the engines that it creates ; just as a race that knew and cared for nothing but the humanities would end its life in dreams or in some cloister of the mind. Neither the perfect scientist nor the perfect humanist, he believes, can hope to reach human perfection. Scientific men are conscious of the weakness in the educational system which leads to their growing up ignorant of the humanities, and students of the arts ignorant of science. He therefore thinks that the danger would largely be averted if all education, before specialization claims the pupil, were to include at least the rudiments of training in the value of honest thought, of a fair but critical mind and of the beauties of literature and art.

This recognition of the cultural values of science, and the attempt to formulate specifically, if tentatively, our ideas as to a general education not merely for scientific workers but also for all other university students, coming from such diverse quarters, are welcome evidence that the problems of university expansion are being faced with vision and imagination as well as realistically. That this is so is shown further by the Lord Chancellor's speech in the House of Lords. Lord Jowett spoke immediately after a well-balanced speech by Lord Lindsay of Birker to which reference was made in *Nature* of June 7, p. 755. Lord Lindsay also referred to the place of the universities in meeting the demand for refresher courses, and to the importance of their extra-mural work and particularly their part in adult education. In this extra-mural work for further education, as well as in their internal aims, the universities will find considerable scope for pressing the study of the humanities, especially in so far as they are, or should be, correlated with the sciences.

ADVENTURES AND DISCOVERIES IN ARMY EDUCATION

Adult Education

The Record of the British Army. By Major T. H. Hawkins and L. J. F. Brimble. Pp. viii+420. (London : Macmillan and Co., Ltd., 1947.) 15*s*. net.

IN 1940 it might well seem that "education was the first casualty". Yet, as in the First World War, it was already arising with new vitality, phœnix-like, from the consuming flames. The shape of things to come in Mr. Butler's Education Act was beginning to appear. More immediately, the educational resources of the whole of Britain had been mobilized, through the Central Advisory Council for Education in H.M. Forces and its twenty-three regional committees, to provide mental stimulus and sustenance for the men and women who were being transformed into citizen soldiers, sailors and airmen. In the autumn the members of the Army Educational Corps were brought back from the 'other duties' to which they had been posted, and an immense educational enterprise had been launched with the enemy literally knocking at our gates. Amazing in itself, no effort and adventure on this scale would have been possible in peace-time. But how much was actually done, and what are likely to be the enduring fruits of this enormous experiment in further education ?

This attractive and impressive book is the first full-scale account and assessment of 'Army education' during the War and the release period. The authors had first-hand knowledge of the scheme in action. They are experienced in research. There is not a dull chapter in what they have written. The story is told with admirable clarity, balance, discrimination, and humour. It is neither arid in detachment nor vitiated by prejudice and partisanship. It is extraordinarily well documented, and it is set in the framework of a wide acquaintance with adult education in civil life. The suggestions concerning the application of what Army education has taught us to what the Education Act envisages are well considered and constructive.

To generalize, either appreciatively or critically, on this book of four hundred closely packed pages would be foolish. To particularize would take pages instead of paragraphs. It must suffice to touch upon a few typical points.

The opening chapter is a fascinating record of adventures and activities in Army education from 1747 onwards. Not solely for war-time achievements has the Army Educational Corps now been honoured by the prefix Royal.

The volume and variety of those achievements cannot even be summarized here. Before the Army Educational Corps lay an opportunity such as the civilian bodies have never had—millions of men and women organised into compact units, stimulated to a new interest in the world about them, wanting to keep contact with the unregimented life which previously had bored them, anxious to prepare for a new start 'after the War', and with leisure which they had few means of occupying in satisfying ways. Moreover, there were representatives of every trade and profession (including teachers) available to play the part of 'instructors'. But what should be the aim ? Some (too many) commanding officers said "Morale !", and had no further use for education. But while no sensible man could question the primacy of morale in an army fighting all over the world, or the importance of education in promoting it, throughout the War "Army Education deliberately and consistently sought to provide the means for all of developing their talents as individuals, as citizens, and as breadwinners". The Army Educational Corps tried all ways and all means. If the Army Bureau of Current Affairs tended to make too much of 'discussion-method', it also developed great skill and ingenuity in making and using pictorial, mechanical, and dramatic aids. The chapters on 'Basic Education' and on the A.T.S. reveal the adaptability of administrators and instructors to special needs. Though inevitably much of the work had to be superficial and transient, the Army Educational Corps discovered the art of 'persuasive presentation', practised 'ice-breaking methods', and, as time went on, made increasing use of intensive courses, often residential.

The Corps were ready to learn. This book is full of references to civilian co-operation not only in supplying lectures and teachers or providing courses, but also by contributing advice and suggestions matured by long experience in many forms of adult education. It was sometimes said that the only place where the command education officers of the three Services met for consultation and conference was at the periodical meetings of the regional committees. There were, of course, mutual criticisms, but there was and is a genuine comradeship in a common enterprise.

If the authors of this book had been as closely acquainted with Central Advisory Council records as with those of the Army they would perhaps have been still more even-handed in their narrative and their evaluation. The story from the Central Advisory Council angle will be told elsewhere. Meantime, there are some passages here that need correction. The reference, for example, to civilian lecturers who had to be dropped is rather misleading. Every civilian lecturer was pledged to avoid propaganda. The actual number of offenders was very small, and some of these on inquiry proved to be sinned against, not sinning: 'security' was on occasion made an excuse for prejudice. When Army officers were ordered not to discuss the Beveridge Report officially with their men, because it was still *sub judice* in Parliament, the Secretary of State for War told a protesting House that all was well, for regional committee lecturers were dealing with it, and could be trusted to be impartial. Mr. W. E. Williams' humorous exaggeration about the efficiency of civilian lecturers was, of course, not meant as a serious judgment, and when unit officers were clamouring for a lecture, no matter on what or by whom, each week, regional committees were tempted, or driven, to use 'amateurs'.

Too little is said in the book about the constant plea of regional committees for more sustained work and fewer fugitive lecturers. There is practically no reference to the stream of Central Advisory Council lecturers sent overseas after hostilities ceased, though the distinguished Commander-in-Chief, Middle East, who first opened the door, said recently that they saved the situation, *because* they were civilians, not in uniform, fresh from home, speaking with some authority on their subjects but also with complete freedom.

The work goes on. In their chapter, "Comments and Criticisms", the authors point to the possibilities of great developments both in Army education and in civil life. Their book will long be a valuable aid to those on both sides who believe that there is 'no end to learning', especially from experience, and it will ensure that a unique body of experience is not forgotten.

BASIL A. YEAXLEE

CATALYSIS

La théorie de la catalyse vue d'ensemble et essai de synthèse

Par Prof. Jacques Métadier. (Actualités scientifiques et industrielles, 1005.) Pp. 101. (Paris : Hermann et Cie., 1946.) 200 francs.

THE definition of the word 'catalyst' used to have a quite precise meaning in chemistry, whether catalysis occurred in heterogeneous or homogeneous systems. In recent years 'catalysis' has come to include a tremendous variety of chemical reactions which, strictly speaking, do not involve true catalysis at all. In a similar way, the term 'negative catalysis' did duty until such time that the mechanism of the retardation and inhibition of chemical reactions was more fully understood, when it became abundantly plain that the inhibitor was almost invariably chemically destroyed in the inhibitory reaction. This extension of the meaning of the term has therefore led to the belief that a systematic treatment of the mechanism of chemical reactions is most easily accomplished by treating reactions as catalytic processes.

There is, of course, an element of logic in this attempted classification that arises in the following way. The more the subject of chemical kinetics advances the more it becomes evident that the existence of simple bimolecular reactions is comparatively rare, and that, in fact, most reactions seem to be complex in the sense that the reactants in a system cannot be induced to react unless some body, either derived from the reactants themselves or purposely added, is present to start off reaction. Sometimes that body is regenerated as in chain processes; but this is not always necessary. Furthermore, in the majority of such complex reactions of the homogeneous type there is little doubt that although on the surface catalysis appears to take place, the catalyst is actually chemically consumed during the operation. The question to be decided is whether it is legitimate to extend the term 'catalysis' to all such cases. Prof. Métadier decides for this extension, and consequently cites in his survey a great variety of homogeneous and heterogeneous and even enzymatic reactions where it is difficult to say whether heterogeneous or homogeneous process operates. There is, however, much to be said against this classification. It would be more satisfactory to treat the matter upon the basis of chemical kinetics on which everything rests and to discuss on its merits each type of reaction.

This book, therefore, is a review of chemical kinetics in a compact form. Formal chemical kinetics are briefly surveyed with appropriate definitions of reaction velocity coefficients, and there is a short account of the elements of the quantum theory of reactivity without going into the details of the transition state treatment. Then follows the systematic treatment based not on specific reactions but on types of catalysis, namely, homogeneous catalysis, physical catalysis, heterogeneous and negative catalysis, catalysis by colloids and biological catalysis. Each subject is a vast domain in itself; and therefore only very brief descriptions can be given of suitable examples in these several fields without going into any critical discussion of the data. There are, unfortunately, no references, so that the inquiring reader cannot pursue the matter further. The reviewer feels, however, that the time has come when such an extension of the scope of catalysis is practically impossible and is perhaps now undesirable.

H. W. MELVILLE

A GERMAN VIEW OF THE ATOM BOMB

Die Geschichte der Atombombe

Mit einer elementaren Einführung in die Atomphysik auf Grund der Originalliteratur gemeinserständlich dargestellt. Von Hans Thirring. (Wissenschaft für Jedermann.) Pp. 150. (Wien: Neues Österreich Zeitungs- und Verlagsgesellschaft m.b.H., 1946.) n.p.

PROF. THIRRING was dismissed from the chair of theoretical physics in the University of Vienna by the Nazis because of his democratic views and his association with anti-militaristic movements, was persecuted by the Gestapo, and was reinstated only after the downfall of the Nazi regime. The author certainly is well qualified politically to interpret the significance of atomic energy in a popular book to a German-speaking public. The reviewer considers that Thirring has admirably succeeded in the task he has set himself. The book provides an elementary introduction to the structure of the atom and the nucleus, a history of the attempts in the Allied countries (on the basis of the Smyth Report) and in Germany to make use of atomic fission, and a short evaluation of the political aspects of atomic energy. The book is written in a clear and fresh style enlivened by sarcastic remarks against the treatment of science under Nazism.

The author stresses the necessity of an expe counteracting the fantastic rumours circulating i Central Europe: "There were people who claime to know that the whole atom bomb business w nothing but a bluff . . . again others thought th Americans had been enabled to build the bomb onl by the booty of knowledge and material captured i the conquest of Germany, and it was stated th German inventions had been surrendered to Englan and America by traitors. Thus the old *Dolchstos legende* of 1918 has been revived in a modified shape. It is argued that the advantage of the Allied countries over Germany in the development of atom energy has been primarily intellectual and moral, an only secondarily material and financial. On on hand, the influence of the Nazi physicists Lenar and Stark, who struggled for 'German' as oppose to 'Jewish' physics, prevented Germany fro keeping abreast of the scientific developmen abroad; Hugo Dingler, a philosophical protagonis of the Lenard–Stark tendency, is quoted as havin ridiculed the possibility of a conversion of mass int energy as a "product of an extravagant imagination as late as 1941. On the other hand, Thirring state that many of the best, notably Hahn and Laue, wer quite clear that it would be a crime against mankind to supply the psychopath Hitler with an ato bomb. The net effect was that the Allies were fa ahead of Germany even before the full materi resources of the United States were mobilized for th atom bomb in 1942.

A very large volume of factual material i marshalled successfully by the author, and th small number of errors is surprising. On p. 8 on would like to see mention of Corson, Mackenzi and Segrè, who made element 85 artificially befor Karlik and Bernert announced its discovery as rare branching product of the natural radioactiv series. The reference to the work of Pettersson Stetter and Kirsch (p. 48) strikes the reader as odd Faraday is erroneously associated with Cambridg (p. 54). The paper in *Nature* by Dodé, Halba Joliot and Kowarski, which dealt with the neutron emitted in fission, was preceded by a paper by Halba Joliot and Kowarski, in which the large-scale emission of neutrons was first established (p. 81). Th slowing down of neutrons to thermal energies b pure uranium (p. 86) is scarcely a practical proposition. Chain reactions based on unidentifie natural α-ray emitters (p. 138) do not appear likel

Thirring expresses reasoned optimism concernin the peaceful utilization of atomic energy. Furthe a stimulating discussion of the possibilities of man made explosive nuclear chain reactions, not involvin fission, but requiring ignition by fissile material, i given. The ${}^{2}_{1}D(d,n){}^{3}_{2}\mathrm{He}$ and ${}^{7}_{3}\mathrm{Li}(p,\alpha){}^{4}_{2}\mathrm{He}$ reactions ar mentioned. These possibilities make the task of th establishment of permanent peace based on understanding even more pressing. Quoting Roosevelt an Einstein, the author takes the opportunity to urg the adaptation to this task of our educational systems, and refers to his book soon to be published o "World Peace as a Psychological Problem", in whic he concludes—though he does not blame Americ for having used the bomb in the War: "Whoeve believes in the future of mankind . . . must b imbued with the conviction that man can be taugh that . . . those who triumphantly throw the ato bomb in the last analysis only harm themselves".

E. BRODA

Marine and Air Navigation

By John Q. Stewart and Newton L. Pierce. Pp. xii + 472. (Boston, New York and London: Ginn and Co., 1946.) 26*s*. 6*d*. net.

Coasts, Waves and Weather

For Navigators. By John Q. Stewart. Pp. vii + 348. (Boston, New York and London: Ginn and Co., 1946.) 21*s*. net.

THESE two volumes are typical of publications popular in the United States, but not seen often in Britain. The American reading public evidently appreciates books upon technical subjects, written in sufficient detail to make a volume of appreciable size, but using popular language rather than the more concise and pointed style of the text-book. Such books have their value to the student, and should be of great use for introductory reading. In Britain we seldom see this kind of work. A popular book on a technical subject, in Britain, is usually so small that only the broadest treatment is possible, which, although correct in substance, is not much use to even an elementary student.

"Marine and Air Navigation" covers the whole subject, so far as it can be treated in the classroom, with many clear explanatory diagrams and photographs. The style is empirical, but a wealth of information of use to the navigator is given. Celestial navigation is covered without unnecessary astronomical detail, and some useful coloured "Star Charts" are included. Various maps and tables naturally refer to the American continent in general, and references are almost entirely to American publications, some of which are, however, obtainable in Britain.

"Coasts, Waves and Weather" is a fascinating book for general reading, but is rather the more non-technical of the two. It is not, in any sense, a text-book on meteorology, as its title might suggest. Part 3, "Meteorology for Navigators", treats the subject from the point of view of weather forecasting by the man flying or sailing into it, and does this very thoroughly with the aid of some beautiful cloud pictures. Again, the description and examples of coast-lines, terrains, and oceanography are taken from the American continent, and lose a certain local interest for British readers.

Both books are well worth reading, the few strictly American terms are generally understandable from the sense of the text, and the style of the writing never becomes pedantic. They might be read with interest and advantage by both sailors and airmen, professional and amateur.

Atoms, Stars and Nebulæ

By Leo Goldberg and Lawrence H. Aller. (Harvard Books on Astronomy.) Pp. v + 323. (London: J. and A. Churchill, Ltd., 1946.) 18*s*.

ONE of the most serious defects in astronomical literature is the lack of any authoritative and up-to-date English text-book on astrophysics. The need for such a book is widely felt. This book is not a text-book and it does not deal with all branches of astrophysics, but it partly fills the gap. That it has met a real need is shown by the fact that the present edition is the third reprint since it was first published in 1943. In this reprint various additions have been made to bring the book up to date.

The volume begins with a non-mathematical account of the principles of atomic physics and the theory of light. It then goes on to consider stellar atmospheres, the widths of spectral lines, the formation of absorption lines, the curve of growth, the differences between the spectra of giant and dwarf stars of the same spectral type and related problems. Special classes of stars are then considered: pulsating stars, novæ, planetary nebulæ, and stars with extended atmospheres. One chapter is devoted to the interstellar gas, and a final chapter deals with the source of stellar energy. Several appendixes give much useful information.

The book forms one of the excellent series of Harvard Books on Astronomy. Like all the other volumes of this series, it is very well illustrated. It can be strongly recommended to the student of astrophysics as an authoritative introduction to the subject; it is also a useful reference book for the working astronomer.

Science, Faith and Society

By Prof. M. Polanyi. (University of Durham: Riddell Memorial Lectures, Eighteenth Series.) Pp. 80. (London: Oxford University Press, 1946.) 2*s*. 6*d*. net.

THE Riddell Memorial Lectures, given by distinguished men of science, philosophy and theology, provide a pulpit of great value. One has only to glance through the list of names since the first series was published in 1928 to see how powerful this foundation has become. Into this learned company Prof. M. Polanyi fits extremely well. He discusses "Science and Reality" (1), "Authority and Conscience" (2), and "Dedication or Servitude" (3). There is also an appendix dealing with the premises of science and the question of observation. Through all that Prof. Polanyi has to say shines a passionate desire for truth and for full opportunity to realize it. His background, differing—as it must—from our own in certain ways, is at one with it in its plea for tolerance, and for the inculcation of responsibility in the transmission of tradition. By means of a clarification of man's cultural and social purpose, he will be brought—it is claimed—to a revelation of the Divine.

An interesting point is made regarding seeming irrelevance. Scientific genius consists largely in the ability to pounce upon something fundamental and to follow it up relentlessly, consigning the rest to limbo. Indeed, this is the way to the eternal verities, philosophic and otherwise. F. IAN G. RAWLINS

Population, Psychology and Peace

By J. C. Flugel. (Thinker's Library, No. 117.) Pp. xviii + 142. (London: Watts and Co., Ltd., 1947.) 2*s*. 6*d*. net.

IN this book, Dr. Flugel analyses with acumen the emotional resistances to accepting the doctrine of Malthus, and appears to come down on the side of neo-Malthusianism. His psychological approach is novel and puts into perspective the economic and quantitative aspects of the subject which tend to dominate current discussion. But the calm tone and reasoned exposition conceal many controversial issues. How much truth is there, for example, in his key premise (p. 103) that "the decreasing poverty of the western world is due in considerable measure to the reduction of the birth rate"? Is it true (p. 47) the 'elderly' contribute more to the community and make fewer demands on it than do young children? Nevertheless, the book will be read with much profit by students of demography in general and by members of the Royal Commission on Population in particular. Dr. Joad contributes a lively introduction.

JOHN COHEN

SOME NEW ASPECTS OF MITOTIC POISONING

By Dr. PIERRE DUSTIN*

(From the Chester Beatty Research Institute, The Royal Cancer Hospital (Free), London, S.W.3)

A PROPERTY of many chemical compounds, both organic and inorganic, is to disturb or destroy cells during cell division or when division is about to begin. Two well-known examples are colchicine, which arrests mitosis at metaphase by depriving the spindle of its normal properties, and trypaflavine (3 : 6-diamino-10-methylacridine hydrochloride), which prevents the onset of prophase and leads to extensive nuclear and cellular degeneration[1]. There are undoubtedly close relations between these two types of activity, since colchicine induces in the lymphoid tissues of mammals extensive damage similar to that which led to the discovery of the properties of trypaflavine[2]. A great amount of work has been done on colchicine, following the observation of its polyploidy-inducing properties in plants[3], and numerous substances having similar effects on plant-cells have now been described[4]. Experimental work on mice recently pursued with the purpose of investigating the nature of the action of ethylcarbamate (urethane) on malignant growth[5] and in leukæmia in man[6] has led to the discovery of new mitotic poisons of comparatively simple chemical constitution[7]. This fact, and some other recent advances in this field, makes possible a fresh discussion of the mechanism of mitotic poisoning and of some recently proposed theories.

Mechanism of Nuclear Destruction by Pycnosis

It was the study of substances inducing extensive destruction of the lymphocytes in the spleen, the lymph-glands, and principally in the thymus, which led to A. P. Dustin's discovery of new mitotic or 'caryoclasic' poisons[1,2] and of the cytological effects of colchicine. This alteration of the lymphocyte, consisting of a sudden agglomeration of all chromatin structures in small spherical masses, is named 'pycnosis'. With mitotic poisons of the trypaflavine type, following a period of diminished mitotic activity, irregular Feulgen-positive masses are found in the germinative region of the intestinal mucosa in the mouse. It seemed necessary to re-investigate this last phenomenon, which had been considered by A. P. Dustin and his collaborators[8] as evidence of an intracytoplasmic synthesis of nucleoproteins.

In 1939, Zylberszac[9] found that hydroquinone and pyrocatechol very rapidly produced extensive changes in these intestinal crypts. I have recently studied such changes with various histological techniques (in particular, pyronine-methyl green staining for the nucleolus, and La Cour's[10] lacmoid smear method for the chromatin structures). With hydroquinone, which gives the clearest pictures in the shortest time, the effect is a nuclear degeneration closely resembling the 'pycnosis' observed in lymphoid tissue. The following stages can be identified (Fig. 1) : (1) considerable swelling (hydration) of the cytoplasm, giving the epithelial cell a spherical form ; (2) at the same time or very shortly after, alterations of the nuclear membrane ; (3) accumulation of the thymonucleic acid on the nuclear membrane, with disappearance of all microscopically visible chromosome structures, and fragmentation of the nuclear membrane ; (4) formation of a sphere composed of acidophil (basic) protein + ribonucleoprotein, the nucleolus persisting for some time, and the 'thymonucleic' material forming peripheric shell-like structures ; (5) rapid fragmentation of these pycnoses, with formation of numerous small particles, some Feulgen positive, some negative, the debris being engulfed in the cytoplasm of the surrounding cells (cf. A. P. Dustin[8]), and eventually eliminated towards the intestinal lumen (*'excrétion sphérulaire'*). Although the pictures are more difficult to interpret in lymphoid tissue, there are good reasons for believing that the same sequence of cellular changes precedes the phagocytosis of cellular debris by macrophages of reticular origin.

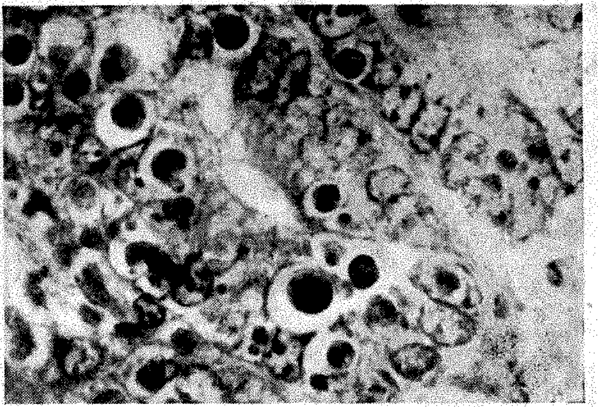

Fig. 1

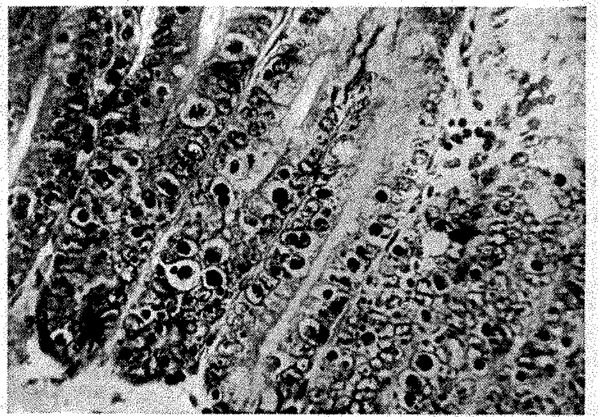

Fig. 2

NUCLEAR AND CELLULAR DESTRUCTION IN THE INTESTINAL CRYPTS OF THE MOUSE

Fig. 1, 4 hr. after 2·5 mgm. of hydroquinone.
Fig. 2, 10 hr. after 5 mgm. of sodium cyanate.

In the intestine, it is evident that such nuclear destruction only takes place in the region of active cellular proliferation, during or after a period of abnormally low mitotic activity. This leads to the conclusion that the cellular breakdown occurs when cells attempt to undergo mitosis. For this reason, one may name this phenomenon 'mitotic poisoning before prophase'.

This interpretation means that only cells which would have undergone division during the period of action of the poison are altered. This affords an explanation of the appearances seen in the intestinal crypts, but it is not so evident that it applies to lymphoid tissue. In spleen and lymph glands, the localization of pycnosis in the germ-centres, where most mitoses normally take place, does, however, point in the same direction; and in the thymus, where most mitoses are found in the cortical region, so too are the pycnoses. But here, the extent of the cellular destruction which may be found within less than twenty-four hours suggests that more cells are destroyed than would have divided in this period of time. Further quantitative study of the number of cells normally undergoing mitosis in the thymus is clearly necessary.

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The thymic atrophy following on pycnosis was found by Selye to be a non-specific change induced by any sublethal action on the organism, the so-called 'alarm reaction'[11], and Selye, Leblond and others were able to demonstrate that the internal secretions of the adrenal cortex played a fundamental part in this cellular destruction[12]. An interesting fact quite recently discovered is that induced pyridoxine deficiency following the injection of desoxypyridoxine also produces extensive pycnotic degeneration in the thymus[13].

Carbamates and Cyanates

Until recently, few substances were known to affect division similarly to trypaflavine or hydroquinone, and most work had been devoted to substances modifying division in a manner similar to that of colchicine.

Ethylcarbamate (urethane) has now been found to modify the cellular divisions in the intestine of the mouse[7]. This action is much slower than that of hydroquinone, marked pycnotic destruction occurring only eight hours after the injection, and being still very conspicuous twenty-four hours later. At the same time the mitotic activity is abnormally low, and it seems clear that only the cells which should have divided are destroyed by ethylcarbamate. In thymus and lymphoid tissue, no evidence of mitotic poisoning is found after a single injection. Ethylcarbamate is thus a slow-acting mitotic poison with activity of the 'trypaflavine' type.

Investigation of other carbamic esters has so far shown that similar effects are produced by ethylphenylcarbamate, isopropylphenylcarbamate and β-chloroethylcarbamate. It is remarkable that methylcarbamate, even in big doses, does not interfere at all with mitosis in the mouse, and is without the narcotic properties of the other carbamic esters tested. Negative results obtained with ethyloxamate (oxamethane) and with the narcotic chloretone (known to affect mitosis in Urodele larvæ[14]) show that the action of carbamic esters has some specificity.

It seemed of interest to investigate other substances related to urethane and having similar effects. Cyanate was suggested by Dr. Schütz, following recent work on the hypnotic properties of sodium cyanate[15]. It was also suggested to me (by Dr. F. L. Rose) that cyanate and urethane may both enter in combination with amino groups following the reactions:

$$HCNO + NH_2R \rightarrow NH_2CO{-}NHR$$

$$NH_2{-}CO{-}OC_2H_5 + NH_2R \rightarrow NH_2CO{-}NHR + C_2H_5OH.$$

In mice, sodium cyanate was found to have cytological effects similar to those produced by urethane, and caused extensive pycnotic degeneration in the intestine (visible six hours after a single injection of 5 mgm.) (Fig. 2). In the germ-centres of splenic lymphoid tissue and in the cortical region of the thymus there is also marked cellular destruction by pycnosis, repeated injections leading to a complete destruction of the small cells of the thymic cortex. Thus cyanate is also a mitotic poison of the trypaflavine type, with greater toxicity and more powerful effects than ethylcarbamate. It was also found that potassium thiocyanate (5 and 10 mgm.) had a similar action, the intestinal pycnoses being very conspicuous, and lymphoid pycnoses less numerous than after the injection of cyanate. These results are interesting when compared with the findings of Barker, Lindberg and Wald[16], who noticed anæmia, and blood and bone-marrow changes "resembling benzene poisoning", in dogs given repeated injections of thiocyanate; this substance has been extensively used in the treatment of human hypertension[17].

In a recent review on mitotic poisons[18] I pointed out that similar substances may be formed within the organism. It has been suggested by Schütz that ammonium cyanate exists in thermodynamic equilibrium with urea and may be a normal constituent of the mammalian organism and play some part in the intoxication of uræmia:

$$NH_2.CO.NH_2 \rightleftharpoons NH_4.CNO.$$

It has been reported[19] that extensive pycnotic destruction of lymphoid tissue followed bilateral nephrectomy in the mouse. This experiment was repeated in order to decide whether the typical intestine changes found in cyanate poisoning existed also in this condition. In two mice which survived the operation for twenty-five and twenty-nine hours respectively, considerable destruction was found in the thymic cortex and in the splenic lymphoid tissue, but the intestinal mitoses were not at all affected. These experiments, which are somewhat similar to those of Selye[11], do not suggest that cyanate accumulates in the tissues as a consequence of acute renal failure. Cyanate is so far the simplest organic compound capable of poisoning mitosis, and its further study should be expected to throw more light on the chemical mechanisms involved.

'Nitrogen-Mustards'

The pharmacology and toxicology of the *bis*-(β-chloroethyl)-amines ('nitrogen-mustards') have been studied during recent years (Gilman and Philips[20], Dixon and Needham[21], and Rhoads[22].

These substances have a special toxicity for cells in division or about to divide, and their cytological action appears limited to the germinative layers. In a study of the action of methyl-*bis*-(β-chloroethyl)-amine on the divisions in the intestine and blood-forming organs of the mouse, the cytological changes were found to be identical with those observed after cyanate or ethylcarbamate poisoning, especially in the intestine, although the chloroethylamines differ from other mitotic poisons of the trypaflavine type in the comparatively small quantities (for example, 0·5 mgm./kgm. of body weight) which are effective. In rapidity the action on the intestine equals that of hydroquinone.

These results are of special interest in relation to work on the enzyme-inactivating properties of nitromustards and their possible poisoning of phosphokinases[21].

Arsenic and Dimercaptopropanol (*BAL*)

Following a paper by Wätjen[23], inorganic and organic arsenical derivatives were extensively studied in A. P. Dustin's laboratory by Piton[24]. They were found to have two possible actions: (1) destruction by pycnosis of lymphoid cells; (2) accumulation of numerous pathological mitoses arrested at metaphase. This last effect—identical with that of colchicine—was most apparent after the injection of cacodylate.

Thus arsenical compounds belong to the two groups of mitotic poisons previously defined.

The recent discovery of the remarkable detoxicating properties of dimercaptopropanol (*BAL* = British anti-lewisite[25], a specimen of which was kindly provided by Prof. R. A. Peters), suggested the following experiments, aimed at testing whether the mitotic poisoning by arsenite may be reversible. The metaphase-arrest was studied in bone-marrow preparations by the lacmoid technique[10]. It appeared that within one hour after the injection of sodium arsenite, most mitoses were stopped at metaphase without serious chromosome alterations. Then, a dose of dimercaptopropanol, slightly bigger than that required to neutralize the arsenic, was injected. The results of a typical experiment given in Table 1 show that a significant fraction of the arrested metaphases has been able to build a normal spindle and to proceed to telophase.

TABLE 1. REVERSAL BY 1·5 mgm. OF DIMERCAPTOPROPANOL (INJECTED ONE HOUR LATER) OF THE MITOTIC ARREST AT METAPHASE PRODUCED BY 0·3 mgm. OF SODIUM ARSENITE (BONE-MARROW OF THE MOUSE)

	Arsenite alone			Arsenite + *BAL*		
Hours	Pro-phases	Meta-phases	Ana- and telophases	Pro-phases	Meta-phases	Ana- and telophases
1	16	79	5	—	—	—
2	4	94	*2*	2	74	*24*
4	2	95	3	1	89	10
5	—	—	—	1	93	*6*
24	5	63	32	11	59	30

The table also shows that the effect of dimercaptopropanol diminishes in a few hours, although there is no difference between the two series of animals after twenty-four hours. The quantity injected being sufficient to neutralize all the arsenite injected, it was suspected that *BAL* alone might modify the percentage of mitotic phases in the bone-marrow. This was in fact found: two hours after a single injection of 1·5 mgm. of dimercaptopropanol, the percentage of phases in the bone-marrow was: pro-, 3; meta-, 92; ana- and telophases, 3. Four hours after, 88 per cent metaphases were found, and these exhibited the same spindle defect as caused by arsenite. Dimercaptopropanol is in consequence also a mitotic poison, with activity similar in type to that of colchicine.

In the thymus and intestine, the same reversal of the arsenical mitotic arrest is found, as the following figures make clear:

TABLE 2. SAME EXPERIMENTS AS TABLE 1
Percentages of mitotic phases in thymus and intestine

	Pro-	Meta-	Ana- + telophase
Thymus, 4 hr. after arsenite	1	95	4
1d. and 3 hr. after *BAL*	2	60	38
Intestine, 4 hr. after arsenite	2	94	4
1d. and 3 hr. after *BAL*	5	46	49

Injection of dimercaptopropanol also prevents the 'pycnotic' effect of arsenite. In the control animal, twenty-four hours after the arsenite injection, the thymus shows few mitoses and extensive destruction by pycnosis. In the animal detoxified by *BAL*, the thymus does not present any evidence of cellular breakdown, and mitotic activity is normal. Similar pictures are to be found in the germ-centres of the spleen.

Apart from affording new evidence of the efficacy of *BAL*, these experiments are somewhat difficult to interpret. They would seem to suggest that the mitotic poisoning by arsenic is related to its action on —SH groups: arsenic might be removed from the cellular (spindle ?) —SH groups by the more reactive similar groups of *BAL*. On the other hand, it may be argued that arsenic has been removed from the organism by the greater diffusibility of its combination with dimercaptopropanol, and that no further evidence can be gathered as to the combination of arsenic and the cellular constituents at metaphase. The poisoning of metaphase by *BAL* itself certainly makes the problem more complex.

In order to test further substances with a pharmacological behaviour similar to that of arsenic and known to react with —SH groups and to poison —SH enzymes, some experiments were done with sodium selenite[26]. This was found to induce extensive pycnotic destruction of lymphocytes in thymus and spleen (5 mgm./kgm.). In the intestine, there was a slight increase in pycnotic nuclei. No metaphase arrest was observed in any tissue.

Mitotic Poisons and Ionizing Radiations

Research on mitotic poisons has demonstrated that two periods of the cellular cycle are outstandingly sensitive to chemical interference: the metaphase, or more exactly the formation of a normal polarized anisotropic spindle, and a certain period preceding prophase. The poisoning of the latter stage, corresponding probably to the increase of the thymonucleic acid content of the chromosomes, leads to nuclear destruction by 'pycnosis'. We have given several new instances of poisons acting in this way. All these produce in common an extensive destruction in the germinative regions of the lymphoid tissue and in the thymus. As A. P. Dustin pointed out many times[1,2], these effects are remarkably similar to those of ionizing radiations: the mitotic poisons of the trypaflavine type are *radiomimetic*.

This resemblance is made more suggestive by recent developments in the cytological study of radiation-effects[27], pointing to the great radiosensitivity of the period preceding prophase. When a cell is irradiated during this period it becomes incapable of normal mitosis and breaks down. The various types of nuclear destruction identified by Spear and Glücksmann[28] correspond closely to those we have met in intestine and lymphocytes. Thus the microscopical appearances of the Lieberkühn crypts after irradiation with X-rays, and after poisoning by ethylcarbamate, seem to be identical.

These facts suggest two possible explanations. The radiations may bring about the formation in the tissues of substances acting like mitotic poisons. The experiments of Schütz show the interest of cyanates in this regard, and further work along this line seems desirable. On the other hand, it may be that ionizing radiations inhibit or destroy some fundamental cellular system which is not necessary in the resting stage but becomes indispensable before prophase. Much recent work on radiations[27] indicates the possibility of the inactivation of enzymes: it will now be seen if such a hypothesis fits in with what is known about the mitotic poisons.

Recent Theories on the Mechanism of Mitotic Poisoning

The large amount of work—mostly botanical—which has followed the discovery in 1937 of the polyploidizing action of colchicine has led to the study of numerous substances with similar properties in plants, and some general theories on their mode of action. Both Gavaudan[29] and Levan and Östergren[4] have suggested a close relation between narcosis and the inhibition of spindle-formation, according to which metaphase arrest might be related to the physical properties of the poisons, in particular their lipo-solubility. Such theories may provide an explanation of the activity of various benzene and naphthalene derivatives, but do not make clear why the water-soluble alkaloid colchicine, or arsenic and mercury compounds, may alter cell division in an identical way. The recent papers of Levan[30] and Thomas[31], bringing evidence of metaphase poisoning with various metal salts and with lactic acid, show that a new approach to this problem is needed.

One hypothesis, which has not so far been put forward, though it seems suggestive, is that the various mitotic poisons act as enzyme-inhibitors, preventing either the onset of prophase or the polarization of the spindle. Of the substances studied in this article, hydroquinone, arsenic, selenite, nitrogen-mustard, carbamates and dimercaptopropanol are known to poison various enzyme systems more or less powerfully, and this property constitutes a link between them which is provided neither by their chemical nor by their physical properties.

Though hundreds of papers have been devoted to colchicine, four only have considered its action on enzymes[32], and new research in this field is urgent. It is not yet possible to assess whether one typical effect—pycnosis, for example—is induced by the poisoning of one enzyme, or if different inhibitions may lead eventually to the same cytological picture. It may be suggested that the poisons of the trypaflavine or radiomimetic group disturb nucleoprotein metabolism and the coating of the chromosomes with thymonucleic acid at prophase. This could undoubtedly be realized by various means. For example, trypaflavine, as a basic dye, may combine with nucleic acid, and carbamates may conceivably interfere with purine metabolism[5]. The poisons of the second type, acting principally on the spindle, may perhaps combine with the —SH proteins that have been histochemically demonstrated in the spindle and also in the nuclear sap[33]. In this group one may tentatively place arsenite, mercury compounds (ethyl-mercuric-chloride[34]), and the halogen derivatives of benzene and naphthalene[4]. The curious cumulative effect of ethyl-mercuric-chloride and dibenzanthracene may be mentioned in connexion with this hypothesis[35]. Other possibilities of enzyme poisoning are indicated by the colchicine effects of ethylcarbylamine[36] and of dimercaptopropanol, which both inhibit metal-enzymes.

Another problem concerns the site of action of mitotic poisons in the cell. It is widely believed that, in a way similar to radiations, they are essentially *nuclear* poisons. While this is evident for those of the trypaflavine group, the close relationship between the spindle formation and the nucleus (in particular after the disappearance of the nuclear membrane), and the pycnotic effects (in mammals) of most of the colchicine-type of poisons, suggest that these also interfere with a nuclear mechanism. It has been thought[27] that the nuclear disturbances induced by radiations may be a consequence of an alteration of the nucleolus. This does not seem to be the case with radiomimetic poisons, the nucleolus being apparently more resistant than the other cellular structures, as described above. We would suggest the possibility of changes in the nuclear sap. Here must be mentioned the interesting work of Haas[37] on nuclear poisons studied independently of cell division. In living Anodont eggs some substances were noticed to bring about intranuclear precipitations visible with the ultramicroscope. The three substances which had the most elective action on the nucleus, without modifying the cytoplasm, were the mitotic poisons caffeine[38], nicotine[39], and colchicine. Very little is known about the properties of the nuclear sap, the function of which, as an intermediary between genes and cytoplasm, is of the greatest importance. Changes in the nuclear sap may possibly give an explanation of the relations between the two types of mitotic poisoning.

Apart from the possible practical utilizations of mitotic poisons in the chemotherapy of malignant growth (ethylcarbamate[6], arsenic, colchicine[40], nitrogen-mustard[22], trypaflavine[41]), and their wide use in applied botany, it is evident that the study of these substances may increase our fundamental knowledge of the cytochemical processes of cellular division. The action of mitotic poisons on various enzyme systems needs further research, which may bring results of far-reaching importance.

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PROF. PAUL LANGEVIN, For.Mem.R.S. (1872–1946)

ON May 23 and 25, scientific workers in Great Britain united to honour the memory of Paul Langevin, whose death last December was felt as a deep loss, not only to science but also to the cause of peace and social justice throughout the world.

The first meeting was a reception at the Society for Visiting Scientists, at which Prof. Joliot-Curie and the British Minister of Defence, Mr. A. V. Alexander, spoke of the contribution of Langevin to science and culture in France, and particularly to the development of the ultra-sonic detection of submarines in the First World War, which was used to such effect in the Second World War.

The second meeting, organised by the World Federation of Scientific Workers in conjunction with the Society for Visiting Scientists and the Association of Scientific Workers, was a public meeting under the chairmanship of Sir Henry Tizard, and was addressed by the Astronomer Royal, Sir Harold Spencer Jones; Sir George Thomson, who spoke of the early life and work of Langevin at the Cavendish Laboratory under his father, Sir J. J. Thomson, in 1897; Prof. J. D. Bernal, who had particularly close contact with Langevin in his later years; and by M. Biquard, of the French Commissariat of Atomic Energy and the Paris School of Physics and Chemistry, the assistant and friend of Langevin, whose moving address in memory of his master will long be remembered by those who heard it.

Paul Langevin was born in Paris in 1872 of working-class parents, and it was from his father in particular that he acquired the sense of popular republicanism that guided him throughout his life. He succeeded, through his own efforts and the obvious brilliance of his intellect, in securing an education in the École de Physique et de Chimie of the City of Paris, from which he had the great fortune of securing a scholarship to work in Cambridge in 1897. He had already absorbed the best of classical French mathematics and physics teaching, naming as his masters Brillouin and Pierre Curie, whom he afterwards succeeded as director of the School. Thus he was most fitted to profit by the really extraordinary opportunities of the Cavendish Laboratory, in the very first year that the University of Cambridge admitted foreign students, having among his companions, Rutherford, C. T. R. Wilson and Townsend. J. J. Thomson had just discovered the electron, and the significances of that discovery were being furiously pursued by these first Cavendish research workers. Langevin's own work was on the recombination and mobility of gaseous ions, and he showed his mastery of the practical and theoretical difficulties in the primitive but stimulating 'sealing wax and string' period of those days. His thesis on this subject (published in 1902), dedicated to J. J. Thomson, was shown at the meeting. His subsequent scientific work exhibited the combined influence of the practical and common-sense English school with the clarity and generalizing power of the French. Indeed, it went further, for Langevin contributed notably to the great theoretical clarifications of that period, both in the field of relativity and the quantum theory. Particularly he put forward, independently of Einstein, the celebrated law of the equivalence of mass and energy, $E = mc^2$, and he was largely responsible for the introduction of these modern views into French science.

The main trend of Langevin's scientific work lay, however, in the direction of the interaction of systems. He was able, in 1907, to explain the phenomena of paramagnetism observed by Curie as due to the mutual interaction of elementary magnets under the influence of thermal agitation, and thus, by the celebrated Langevin equation, to lay the foundations of the study of what are now known as co-operative phenomena, which are seen to-day to be the key to some of the most important features of the solid and liquid states of matter.

In the First World War Langevin turned his talents, as theorist and experimenter, to the development of ultra-sonic vibration by the use of piezo-electric oscillators. The immediate application of this was to the detection of submarines by the reflexion of these waves. In this new field he overcame all experimental difficulties, and already in 1917 was able to demonstrate the detection of submarines under water at a distance of a kilometre. This method was not in operational use in the First World War, but it was the basis of the 'Asdic' which was of such offensive and defensive value in the Second World War. Indirectly, it had even more widespread effects. Piezo-electric oscillation came to be used in many other applications in the electronic field, and echo detection, using electronic instead of sound apparatus, was, of course, the basis of radar and its modern application in war and peace.

The main value of Langevin's scientific contribution, however, was indirect and explicitly appreciated only in France. The many years that he taught at the École made that institution the centre of formation for a brilliant school of French physicists, of whom Joliot-Curie is the most illustrious. Langevin was always interested in scientific education, and in the latter years of his life was given the direction of the reform of this education in France, a reform long overdue, but one for which his particular combination of enthusiasm and breadth of outlook most fitted him.

Paul Langevin, however, will be remembered in France and throughout the world even more as a man and as a citizen than as a scientific investigator. From his early scientific days he realized the obligations of the man of science to fight for justice, in supporting the protests against the condemnation of Dreyfus. "Those were happy times," he said later, "when the fate of a single man was so valuable that it could excite the whole of mankind." The fight he began then he carried on for the rest of his life. He was active in the Ligue des Droits de l'Homme and became its chairman after the brutal murder of Victor Basch and his wife by French Fascists. The advent of the Nazis to power in 1933 put France in the forefront of the fight against Fascism, and Paul Langevin took a leading part in organising it. He was one of the founders of the Comité de Vigilance des Intellectuels Anti-Fascistes, and after the Fascist riots in Paris in 1934 he also took a great part in the formation of the Front Populaire.

It was at this point that his activity in the international sphere also began. He, first among eminent men of science of the world, called for a rallying of all forces against the threat to liberty and progress that Nazism represented. He was able, by his action, to show how possible, and indeed how necessary, it was, to combine, when the times demanded it, the role of citizen with that of scientist. He was instrumental in founding in Britain an analogous body "For Intellectual Liberty" which, together with the Comité de Vigilance, carried out an unceasing activity of protest against the successive surrenders to Fascism, beginning with the Anglo-German naval treaty, continuing through the farce of non-intervention to the capitulation at Munich.

As such, Langevin was inevitably a marked man after the German occupation. He had courageously refused to leave France, though he might easily have done so, and he had the honour to be arrested by the Gestapo on the basis of the *Führerprincip* as the most representative of all the intellectuals who had fought against Hitler. The main charges against him were his chairmanship of the Ligue des Droits de l'Homme, and because he had tried to prevent Germany from ridding itself of the Jews. He was released from prison partly as a result of the protests of French students and professors, but kept under confinement at Troyes, from which he was rescued by the Resistance after some years, and smuggled into Switzerland. He had to suffer more, however, from the fate of his family. His son-in-law Solomon was shot for his part in the Resistance movement, and his daughter Hélène was sent to the notorious death-camp at Auschwitz, from which, however, she managed to escape. Broken in health but not in spirit, Langevin returned to Paris after the liberation, where he took the place which had been occupied by his son-in-law in the Communist Party, and at a great meeting in the Sorbonne was accorded the homage not only of the French intellectuals, but also of the people of Paris and the fighters of the Resistance movement.

The last task of his life was the reform of education, in which he embodied his ideals of social reform. "The final objective would be to find for the individual in human society his rightful place in every respect. Society will then appear to every one of its members as a living entity in which each of us is entrusted for a while with a treasure of civilization acquired by our ancestors at the price of innumerable hardships and pains, which it is our duty to pass on after enriching it according to the extent of our ability. . . . Let us hope that every child, on leaving our schools of to-morrow, will be convinced that the two moral sins of conformity and selfishness respectively oppose the double imperative duty of personal achievement and social solidarity."

The meetings which have been held in his memory in Paris and now in London serve to emphasize the growing unity of science and society throughout the world, and in particular the close ties that have been forged by the experience of recent years between the scientific workers of Britain and France. It is in furthering this unity that we can best honour the memory of Paul Langevin. J. D. BERNAL

CENTENARY OF THE INSTITUTION OF MECHANICAL ENGINEERS

By R. H. PARSONS

THE Institution of Mechanical Engineers, which has celebrated its centenary this week, can look back upon a hundred years of invaluable service both to the profession and to the community. Its existence has been contemporaneous with almost incredible developments in engineering, metallurgy and general science brought about largely by the work of its members. When it came into being, engineers had no such materials as even mild steel or aluminium, no mineral oil, no artificial abrasives, no electrical generators and no internal combustion engines of any kind. Their machine tools were comparatively few and simple, screw-threads had not yet been standardized, precision measurements were impossible, and scientific knowledge applicable to engineering problems scarcely existed. The steam engine, much as it had been left by Watt, was, however, available for industrial purposes, locomotives were running on the railways, and steam had been applied to marine propulsion.

The Institution was founded in Birmingham on January 27, 1847, by a meeting of some of the leading mechanical engineers of the day, and George Stephenson, who had taken an active part in the proceedings, was elected by acclamation as its first president. The object of the Institution, in the words of its founders, was "to enable Engineers . . . to meet and correspond, and by a mutual interchange of ideas . . . to increase their knowledge and give an impulse to inventions likely to be useful to the community at large". Birmingham was decided on as its headquarters, as being the most convenient centre for engineers engaged either directly or indirectly with the development of railways, which then constituted one of the most important fields for engineering activity.

After the death of George Stephenson on August 12, 1848, his son Robert, who acquired the same unrivalled eminence as a railway engineer, was elected president of the young Institution. Other well-known names, such as Fairbairn, Whitworth, Penn, Armstrong, Napier and Siemens among the early presidents, bear witness to the prestige the Institution has enjoyed since its inception. In 1856 it took a step which greatly extended its influence and usefulness. This was the inauguration of its annual summer meetings, lasting two days or more, and held in some selected industrial centre or sometimes abroad. Such meetings have remained among the most appreciated functions of the Institution. An outstanding event in the history of the Institution took place in 1877, when the headquarters were transferred from Birmingham to London. At this time the membership was somewhat more than a thousand. In 1895 it began the construction of its present worthy home at Storey's Gate, St. James's Park. This was formally opened in 1899, and considerably extended in 1913. By then the Institution comprised more than six thousand members, and the rapidity of its subsequent growth is shown by the fact that at the end of last year it had almost 25,000 members of all classes, to which must now be added the considerable number of members recently admitted by the absorption of the Institution of Automobile Engineers.

The increase of membership from all parts of Britain led, in 1920, to a measure of decentralization, whereby local branches, managed by their own committees, which are represented by their chairmen on the Council of the Institution, were established in large centres of population. There are now nine such branches, covering between them the whole of Great Britain, each providing opportunities for its own discussions and other activities. Similar branches also exist in China, the West Indies and the Argentine, while advisory committees serve the interests of the Institution in seven other countries overseas. Another outcome of the increased membership has been the formation of specialized groups within the Institution. These are composed of engineers having a common expert interest in particular subjects, as, for example, steam, hydraulics, internal combustion engines, manufacturing, education, and so on. These groups are assisted by the Council in arranging their own meetings and discussions.

Thanks mainly to benefactions by its members, the Council of the Institution now has at its disposal valuable funds for the provision of monetary awards or medals for special lectures or particularly meritorious papers. One of its highest awards is the Watt International Gold Medal, which is bestowed biennially on some distinguished engineer, without regard to nationality, for exceptional services to science or industry. The decision is made by the Council in the light of the opinions of the leading foreign institutions, and the recipients so far have included two Englishmen, two Americans, one Australian and one Swiss. Some of the other prizes are awarded in respect of specified subjects, but in the case of others the Council has a wide discretion. Any person, for example, whether a member of the Institution or not, may be invited to deliver the well-known annual Thomas Hawksley Lecture. Lectures in this series have been delivered by such authorities as the late Sir Alfred Eddington, the late Lord Rutherford and others of similar eminence. In 1945 the Institution received the magnificent bequest of £130,000 under the will of the late Mr. James Clayton, with the condition that at least one quarter of the annual income should be used in providing a "James Clayton Prize" for the best contribution by any member in that year to modern engineering science. The first award under this bequest was made to Air-Commodore Frank Whittle for his development of jet-propelled aeroplanes.

It may fairly be claimed that no other technical organisation has so fine a record as the Institution of Mechanical Engineers in the matter of corporate research work, carried out for the benefit of the profession in general. So long ago as 1875, the Council adopted a policy of giving financial support to engineering research, and in 1879 it appointed a standing research committee to decide on and supervise such investigations as might be desirable from time to time. Very large sums have been spent by the Institution on such work, which has been carried on uninterruptedly ever since. The results of the various investigations form the basis of discussions by the members, and are then published for the benefit of all persons interested. The range of subjects is too great even for a summary here, but mention ought at least to be made of the classical experiments of Beauchamp Tower in 1882, on which the whole of the modern theory of lubrication is based, and of the work of the Alloys Research Committee which was started under the direction of Sir William Roberts-Austen in 1889 and has since been productive of immense advances in metallurgical knowledge. The Institution also took up the question of standardization at an early date, and played an active part in the establishment of the Engineering Standards Committee in 1901, to which body matters concerned with standardization have since been referred.

The Institution Library now comprises more than 35,000 volumes, arranged accessibly for consultation, and also available for loan to members who wish to borrow them. There are, in addition, some two hundred British and foreign current technical periodicals in the Reading Room. Visits to the Library or Reading Room now exceed 10,000 annually. The assistance and advice of the staff are, moreover, at the disposal of members seeking information either personally or by correspondence, and the necessary searches are carried out for them.

To maintain the high standard of qualifications required for admission to the Institution, after 1912 the election of the younger candidates was made conditional on their passing an examination in general and technical knowledge in addition to the conditions previously demanded, except in cases where the possession of an approved degree or diploma rendered any further examination unnecessary. The interest and the influence of the Institution in engineering education led to its being consulted by the Board of Trade in 1921 when the advisability of revising the old "Science and Art" examinations was under consideration. The outcome of these discussions, largely due to the late Dr. H. S. Hele-Shaw, was the establishment of the present system of National Certificates in Mechanical Engineering. These are granted on the result of examinations in which assessors appointed by the Institution can set up to 40 per cent of the questions, and can render compulsory any particular questions up to the same percentage of the total. The Institution thus exercises a very strong influence on the type of education given. The certificates awarded bear the signatures of the president of the Institution, of an official of the Board of Trade, and of the principal of the educational establishment concerned. The number of students who sat for these examinations in 1946 was nearly 12,000. The Institution shows its confidence in the scheme by exempting the holder of a Higher National Certificate from further examination in the subjects covered.

In 1929 the Institution of Mechanical Engineers was granted a Royal Charter in recognition of its position as the accepted embodiment of the profession. As such it enjoys the patronage of H.M. King George VI, and, apart from the services of its individual members, it has, in its corporate capacity, rendered invaluable assistance to the Government during and since the War.

OBITUARIES

Sir Granville Orde Browne, K.C.M.G.

SIR GRANVILLE ST. JOHN ORDE BROWNE, who died on May 12, was a pioneer in work for the improvement of labour conditions in the British Colonies, particularly in Africa. Born in 1883, he first went to Africa as an artillery officer in the Zulu War of 1906. In 1909 he joined the administrative service in Kenya; his observations made among some of the minor tribes (Chuka, Embu, Mwimbe, Emberre) were published in 1925 in his book "The Vanishing Tribes of Kenya". Recalled to the colours in 1914, he served throughout the East African campaign, and his experience with native carriers aroused the interest in native labour which dominated the rest of his life.

Orde Browne was posted to Tanganyika in 1920, and in 1926 became labour commissioner, the first holder in Africa of such a post. His "Report on Labour in the Tanganyika Territory", published in that year, was a landmark at a time when many employers still depended on the penal sanction for breach of contract to keep their labourers at work. Most of the points he made have become commonplaces to-day—the need for acclimatization of the labourer to his new surroundings, particularly where these involve a radical change of diet, and for an appreciation of the reasons for 'desertion' and for dealing with it by sympathetic discussion of difficulties rather than by penalties. He advocated measures to mitigate the hardships of the long journey on foot to the place of labour, which have still scarcely been taken on an adequate scale.

When in 1931 Tanganyika decided to abolish the Labour Department and add its duties to the responsibilities of administrative officers, Orde Browne resigned from the Colonial Service, but his interest in Colonial labour questions continued. His book, "The African Labourer", published in 1933, discussed the problems of labour welfare and protection from every angle and compared the practice of the different colonial Powers. In 1934 he became a substitute member of the International Labour Organisation's Committee of Experts on Native Labour, and took part in the drafting of the conventions on recruiting and contracts which have been adopted by that body. He supplied the original draft for the chapter on labour in Lord Hailey's "African Survey".

After being commissioned in 1937 to make an inquiry into conditions on the copper belt of Northern Rhodesia, where there had been serious riots, he was appointed labour adviser to the Secretary of State in 1938, and in turn visited and reported on the West Indies, West Africa, Ceylon, Mauritius and Malaya, and East Africa. The creation of a specialist Labour Department in every Colony, which he persistently advocated, is now official policy. He was created C.M.G. in 1942 and K.C.M.G. in 1947. LUCY MAIR

Prof. Walter Ramsden

PROF. WALTER RAMSDEN, emeritus professor of biochemistry in the University of Liverpool, died on March 26 at the age of seventy-eight. He went to Liverpool from Oxford in 1914, following Benjamin Moore in the chair of biochemistry. The subject was still in its infancy, attracting comparatively few graduates and scarcely any science students. Ramsden's teaching was mainly concerned with medical undergraduates, and for them he introduced for the first time a course of lectures in the subject, together with practical classes. These admirably covered general principles, but did not overburden the student with detail. The result was that when the medical student had passed the second M.B. examination he entered the hospital wards with an interest in the biochemical problems of disease—an approach which at that time was comparatively new and exciting.

Ramsden was a shy, retiring man, and his formal lectures could scarcely be heard beyond the front two rows. Moreover, his tiny handwriting, whether on the blackboard or on paper, was difficult to read. Students often react to this situation by merciless ragging; but his gentleness and old-world courtesy captured them, especially as they appreciated that they were listening to a distinguished scholar and pioneer in his subject. In individual contacts, as when answering questions after the formal lecture, or in the practical class, he was at his best. His nicknames ("Rammer" at Oxford and "Rammie" at Liverpool) revealed the kindly affection with which his students regarded him.

His influence upon the Liverpool medical school and upon the University was that of a gentleman, a scholar and a man of science—quiet, unobtrusive, but far-reaching. He planted seeds, almost by stealth, and left them to grow.

Ramsden's main interests lay in the behaviour of proteins and of surface membranes, yet he always found time for young clinicians and others who were feeling their way towards the answers to varied problems, practical or academic. He entered unselfishly and wholeheartedly into their problems, and gave them the guidance and help of a master. He published comparatively little, though he wrote much that never came to publication, for he was almost exasperatingly modest and meticulous. He was rarely satisfied with what he wrote, and as he was always learning from his researches, he never reached that finality which he felt justified publication.

When he retired from the chair at Liverpool in 1930, and returned to Fellows' Room of Pembroke College, Oxford, his friends hoped that more of the material which he had accumulated would be made available for wider study and appreciation. He continued to follow his bent, bred silkworms and studied silkworm protein; but the papers which might have come never came.

He was a personality, and while he was at Liverpool the University and the medical school felt him to be a rare and distinguished possession. A shy and most courteous host, he had a mellow humour and a fund of good stories. ROBERT COOPE

Dr. Seymour Hadwen

ISAAC SEYMOUR ANDRÉ HADWEN, who died recently, was born at Lees, Lancashire, in 1877. He obtained the doctorate in veterinary science at McGill University in 1902, and it is of interest to note that he was a member of a small band that studied the subject at McGill. The Veterinary School there owed its development to a considerable extent to Sir William Osler at the time when he was at the McGill Medical School. The School had a very short life, however, and closed soon after Hadwen graduated. Thereafter veterinary education in Canada was maintained on a less ambitious plane for a good many years, until the course at the Ontario Veterinary College was expanded and its graduates were admitted to the doctorate of the University of Toronto.

Hadwen joined the Health of Animals Branch of the Dominion Department of Agriculture in 1904 and worked for a good many years at Ottawa, and also in British Columbia, on a variety of animal health problems important in Canada; for the latter part of that period he held the post of chief pathologist in that Department. In 1920 he left the Department as he felt that the research branch was not developing in the way he considered it should, and joined the United States Bureau of Biological Survey as chief veterinarian and parasitologist, Reindeer Investigation, in Alaska. From 1923 until 1929 he held the post of research professor of animal diseases in the University of Saskatchewan, and in 1929 became director of the Department of Veterinary Science, Ontario Research Foundation, from which he retired in 1942.

Hadwen was an outstanding man with a great deal of the pioneer in his character. He could study minutiæ and did so constantly; but it was the wide range of biology that attracted him, the play of the environmental factors, and the struggle of animal life to maintain existence. Most of his personal work centred around parasitology, but many other subjects claimed his attention.

Early, in his professional career, Hadwen was associated with the late Prof. G. H. F. Nuttall in studies on the chemotherapy of piroplasmosis in dogs and cattle, in the course of which the fundamentally important discovery was made that trypan blue is specifically curative—a landmark in chemotherapy. He contributed largely to the literature of a problem still unsolved, namely, the causation of bovine chronic hæmaturia, a disease that is endemic in different countries. Ticks and the diseases with which they are associated interested him tremendously, and he had ample opportunity to study the problems concerned. His publications on 'tick paralysis' as it occurs in Canada are still important; the disease has since been studied in Southern Europe, Africa and Australia, but its real nature has still to be demonstrated. He contributed work on the systematic classification of ticks and on their bionomics. Warble flies interested him greatly, and he made important observations on *Hypoderma bovis* and studied other members of the group. Helminth parasites, too, he understood well and studied continuously.

In his later work at the Ontario Research Foundation the subjects were those of importance to the Ontario Province. Much of it was done with Dr. R. Gwatkin and various colleagues, on bovine contagious abortion, mastitis and other problems of intensive husbandry very different from those to which he devoted most of his life.

Hadwen contributed important reports on reindeer; on the management of the herds, fertility in reindeer, their diseases and the manner in which reindeer meat in Alaska could be marketed on a large scale. He had travelled in Labrador and Lapland, studying the problems that had aroused his interests in Alaska. His work and publications indicated measures necessary for the maintenance of health of the herds and the need to change methods that had led, even in such a land of wide open spaces, to seasonal over-crowding with consequent parasitic infestation and ill-health. Wild animals had claimed his attention, and his writings include observations on snowshoe hares and on seals. In addition, he made expeditions to Labrador, and with the East Arctic Patrol to Ellesmere Island.

Hadwen was a member of several learned societies and had been elected an honorary member of the Section of Comparative Medicine, Royal Society of Medicine.

W. A. Pool

Mr. C. H. Creasey, O.B.E.

The death is announced of Clarence Hamilton Creasey at Llangerniew on May 22. Educated at the Royal College of Science, he became principal of Wellingborough Technical Institute, and inspector of technical schools under the Board of Education. He was the author of books on continuation and technical education and was a popular lecturer and broadcaster. He collaborated with Prof. A. S. Eve in writing the "Life and Work of John Tyndall", published in 1945; and with H. G. Wells in "Work, Health and Happiness of Mankind". His book, "Discoveries and Inventions of the Nineteenth Century", published under the pen-name 'Edward Cressy' in 1914, was widely appreciated. Under the same pseudonym, he also wrote "An Outline of Industrial History" (1915), "A Hundred Years of Mechanical Engineering" (1927), "Stories of Engineering Adventure" (1928), "Civil Engineering To-day" (1938). He took an active part in the organisation of education for gas engineers in association with the Institution of Gas Engineers.

NEWS and VIEWS

Trinity College, Cambridge

At the celebration, on June 3, of the four hundredth anniversary of the foundation of Trinity College, Cambridge, the guests of honour were the King and Queen, and the Duke and Duchess of Gloucester. As the royal guests drove across Great Court between crowds of cheering undergraduates, a fanfare of trumpets sounded triumphantly in welcome from above the Great Gate. After a short service in the College chapel, representatives of the town and the university waited upon their Majesties, and the morning's proceedings culminated in lunch in Hall. During the afternoon, a garden-party was held under ideal conditions, and representatives of many different types of College activity were presented to the King. The celebrations ended at five o'clock, except for a very fine firework display late in the evening, which included as a set piece a realistic portrait of the College founder, King Henry VIII.

An outstanding feature of the day was the speech at the luncheon by the King, proposing the health of the College. He spoke of the pleasure felt by the Duke of Gloucester and himself in returning to the College which they entered as undergraduates just after the First World War, and praised the outstanding contributions of members of Trinity in the State, in the humanities and in science. In particular, he referred to the introduction of the principles of inductive logic by Bacon, and their first flowering in the great achievements of Newton. In replying on behalf of the College, the Master also spoke of the extension of natural science in the hands of Maxwell, J. J. Thomson and Rutherford, and mentioned with regret the recent death of another famous Trinity man of science, Sir Frederick Gowland Hopkins. The Master discussed, too, the value of residential colleges in fostering breadth of vision, and encouraging friendship and the free exchange of ideas between those working in the sciences and in the arts. All the friends of Trinity will join in hoping that the contributions of the College to the solution of the problems of to-day and of the future may equal and even exceed the achievements of its illustrious past.

Prof. J. H. Quastel, F.R.S.

The Montreal General Hospital has established an Institute of Special Research and Cell Metabolism under the direction of Dr. I. M. Rabinowitch, and has appointed Dr. J. H. Quastel as director of the Enzyme Research Division and associate director of the Institute, while McGill University has simultaneously announced his appointment to a professorship in the Department of Biochemistry, the chairman of which is Prof. D. L. Thomson. Prof. J. H. Quastel graduated at the Royal College of Science, London, and went to

Cambridge in 1921 as a research student under the late Sir Frederick Gowland Hopkins. These were the pioneering days of enzymology, which saw its development into an exact science, and it was to this field that Prof. Quastel made some of his most important contributions. His exhaustive studies of the resting metabolism of bacteria, which form the basis of present-day microbiological techniques, led to the characterization of new enzyme systems, while his discovery of the specific competitive inhibitors of enzyme action has had the widest application in this field. Prof. Quastel's fundamental contribution at this time was his work on the reversibility of dehydrogenase action. Working with succinic dehydrogenase, he showed that the change in free energy determined from the observed equilibrium point agreed closely with the value calculated from thermal data.

In 1929 Prof. Quastel was appointed director of research to the Cardiff City Mental Hospital, where he investigated the biochemical aspects of mental disease. Fruitful results arising from the integration of clinical and research aspects of these problems has encouraged the development of similar units elsewhere. Following the outbreak of war, Prof. Quastel accepted in 1941 the invitation of the Agricultural Research Council to organise a Unit of Soil Biochemistry at Rothamsted. In this field his work showed the same originality of outlook that was apparent in his earlier work. By repeated percolations of a small quantity of soil by an aqueous solution in a closed circuit and periodic addition of reagents or removal of samples for analysis, detailed qualitative data on soil metabolism, in particular nitrogen metabolism, were obtained. Prof. Quastel was awarded the Meldola Medal in 1927, and was elected a fellow of the Royal Society in 1940. One can with confidence anticipate the development, under his guidance, of a vigorous school of cellular metabolism at McGill University.

Institute of Fuel : New Building

The Institute of Fuel was founded in 1927, soon after the general strike in Britain—a national disaster which started much thought about fuel problems. In several directions action was taken to establish new technical organisations which eventually, by processes of mutual attraction or absorption, led to the foundation of this Institute of Fuel. After ten years or so of useful work, the Institute gathered together about 1,000 members. Then came the War to provide new tasks and opportunities for service which the staff and members were able and ready to seize. As a result, its roll of members has since increased threefold. Regional sections have been formed, schemes of education have been launched, including examinations to qualify for membership, and in 1946 a petition for incorporation by Royal Charter was granted. This year, in order to carry on its work more effectively, the Institute has acquired permanent headquarters at 18 Devonshire Street, London, W.1. It has issued an appeal to all who are interested to contribute sums in support. Already about £8,000 has been received. Cheques should be addressed to the Secretary, Institute of Fuel, 18 Devonshire Street, London, W.1.

Civil Aircraft Research

It has been announced that the terms of reference of the Civil Aircraft Research Committee of the Aeronautical Research Council are : "To consider the basic research problems arising from the evolution and operation of civil aircraft, having regard, *inter alia*, to the probable requirements of the operators ; to recommend periodically to the Council programmes of research ; and to report to the Aeronautical Research Council". The members are Prof. A. A. Hall (chairman), Prof. A. R. Collar, Dr. T. E. Easterfield, Prof. S. Goldstein, Major F. M. Green, Sir Melville Jones, Prof. R. L. Lickley, Dr. H. R. Ricardo, Mr. P. A. Sheppard, Prof. G. Temple, and representatives of the Ministry of Supply, the Ministry of Civil Aviation, the National Physical Laboratory, and the three airways corporations.

Zoological Society of Bengal

The Government of India has recently decided to transfer the office of the Zoological Survey of India from Calcutta to Delhi. As a result, the zoologists of Bengal will be deprived of the use of the only zoological library in that part of the country. In order to meet this difficulty, the Zoological Society of Bengal is issuing an appeal for assistance in the hope that zoologists will present them with reprints of their papers and put the Society on their mailing lists. The Zoological Society of Bengal was only founded last year, but the annual report for 1946 shows that already 294 members have been enrolled and various meetings held. Among the speakers has been Prof. H. Munro Fox, one of the British delegates to the Indian Science Congress Association. The Society proposes to issue monographs of typical Indian animals and also a bulletin dealing with simple zoological laboratory technique. It also hopes to publish a journal devoted to zoological research in India. The president is Prof. H. K. J. Mookerjee, and secretary, Dr. S. P. Ray Chaudhuri. The Society's address is 35 Ballygunge Circular Road, Calcutta.

A Science Journal for South Africa

At a meeting of the South African Association for the Advancement of Science, held in Johannesburg on May 16, it was resolved that the Association should commence publication at the earliest possible date of a monthly periodical covering the whole field of science. The venture will be paid for by the Association and will not be in any way a profit-making organisation ; it is intended that the journal should be distributed free to all members of the Association, and that it may later be made available for sale to the public. It is hoped to present leading articles, reviews of books, and articles of a general character, and to devote three or four pages to "Letters to the Editor", a section which it is hoped will become a forum for scientific discussion. It is intended that articles, etc., should be of such a nature as to appeal to scientific workers in fields other than those of their own speciality, and it is believed there will be sufficient popular material to appeal to the more general reader of scientific interests. The journal will be produced by the Association, the honorary editor being Dr. H. B. S. Cooke, of the University of the Witwatersrand.

American Institute of Physics

The January issue of the *Review of Scientific Instruments* contains an important announcement concerning the reorganisation of the American Institute of Physics. The five societies, the American Physical Society, the Optical Society of America, the Acoustical Society of America, the Society of Rheology and the American Association of Physics

Teachers, which are members of the Institute, have unanimously ratified a change in the constitution under which members of the societies automatically become individual members, without additional subscriptions, of the Institute, thus creating a large unified professional body of physicists. The amended constitution and the new rules are printed in full. No change is made in the organisation, functions or activities of the member societies; but the way is opened for all persons interested in physics to play, individually, a greater part in the affairs and interests of physics, where these are of common concern and can prosper best by the combined active support of all. Provision is made under the new constitution for others, not members of the participating societies, to become associate members of the Institute.

It is intended, when sufficient finance is available, to establish an official monthly journal of the Institute, to be sent without additional charge to all members of the Institute. This journal will contain news about physicists, their meetings, work and other activities, and about similar features in related fields; information about the action of government and other non-physical agencies affecting physics; articles and letters expressing views of physicists on problems of general importance; references to current literature in physics; book reviews, etc. When this journal, for which the title *Physics* has been suggested, appears, the *Review of Scientific Instruments* will revert to a journal devoted exclusively to the science of instruments. It is hoped that associate members, who will be recruited from the very large number of school teachers, students and others who have graduated in physics and thus have an interest in the subject, will be encouraged through the medium of the new journal to become members of one or more of the participating societies.

Fresh Water Biology in Italy

FOUNDED in 1939 by private endowment, the Istituto Italiano di Idrobiologia de Marchi, at Pallanza (Province Novara), is scarcely known abroad. It is situated on the north shore of Lake Maggiore in one of the most suitable and beautiful sites for carrying out research and enjoying the surroundings. Its excellent equipment for field and laboratory research, its spacious accommodation and its sub-station—in a beautiful villa on Lake Como—provide full facilities for any kind of limnological investigation on the great lakes at the foot of the Alps; and a number of smaller lakes all the way up the slopes of the Alps are within easy reach. The main activities of the staff are freshwater ecology, systematics and genetics, a series of papers having already appeared as the Institute's *Memorie*. Free lodging and free laboratory facilities are offered to foreign guests (up to five at one time). Other facilities may be arranged for by agreement with the director, Dr. E. Baldi. Pallanza is easily reached from either of the two international railways, the Simplon and the St. Gotthard.

Radiolocation Convention Papers

As already mentioned in *Nature* (February 1, p. 174), the *Proceedings* of the Radiolocation Convention held at the Institution of Electrical Engineers in 1946 are being published as a series of special numbers of Part 3 of the *Journal of the Institution*. Five such numbers have now been issued, and reference has already been made to the first two. No. 3 contains two papers dealing with some aspects of the propagation of radio waves overland in the wave-length range 10 cm.–10 m.; and nine papers describing the development for radar purposes of special aerial systems for use in the metre band of wave-lengths between 1·5 and 15 metres. The corresponding developments in aerial systems for centimetre wave-lengths are dealt with in a series of six papers forming part of the fourth number (Vol. 93, Part III A, No. 4) of this special publication.

Since it is in the centimetre range of wave-lengths that the wave guide replaces wire circuits and cables for connexions between different parts of the radio-frequency equipment and between the equipment and the aerial system, it is natural to find the twelve papers on wave guides also in this fourth special number. These papers deal with some of the problems involved in design and in the application of wave-guide technique to very short wave radio equipment. The fifth number (Vol. 93, Part III A, No. 5) contains five papers on cathode-ray tubes and twelve on valves. In the first place, these describe some of the advances made in the use of cathode-ray tubes, with special screens in many cases, for radar display purposes. The second series of papers provides a comprehensive record of the special valve development conducted in Great Britain during the War, ranging from triodes for very short waves, the conception and development of that important device, the resonant cavity magnetron, to the high-power pulsed magnetron and the velocity-modulation reflexion oscillator. Since a crystal detector, now termed a crystal valve, is an essential part of all centimetre wave radio receivers, a paper on this subject is included in this particular number of the publication.

National Museum of Wales

THE report for 1946 of the National Museum of Wales again exhibits that activity of service (external as well as internal) which is conformable with the purport of a great institution. In this report the acquisition of St. Fagans Castle and grounds for use as a Welsh folk museum is fully discussed; plans for its future organisation are outlined, and it is stated that part of the new folk museum and grounds will be opened to the public during the present year. An interesting development, and one which would seem to offer scope for the future, was the circulation in 1946 of a travelling exhibition of the Llyn Cerrig and Valley aerodrome finds—finds which had "excited so much interest throughout the Principality and especially in the island" (Anglesey). The exhibits were first set up at Holyhead, where an official lecture was given, then at Llangefni, and finally at Bangor. At each of the first two places it remained four weeks, and at Bangor for a longer period. It is of further interest that this movement was made in response to a request from the Anglesey Education Committee and the Committee of the Museum of Welsh Antiquities at the University College of North Wales, Bangor.

Departmental reports are primarily concerned with routine work, and the work of reorganisation which necessarily follows the return of collections from war-time storage. During the year some of the reference collections were again available for use. Those who believe in the practical educational value of museums under adequate schemes of organisation will be interested in the development regarding the proposed schools service mentioned on p. 20 of the report. This states that the Parliamentary Secretary to the Ministry of Education, Mr. D. R. Hardman, has visited the Museum as a result of a memorandum outlining a scheme which was presented to the Ministry in 1944, and "It is understood that the Ministry is now in consultation with Local Education Authorities in Wales on the matter". Appendixes at the end of the report include lists of acquisitions, publications by members of the staff during the year, and the usual list of the Museum's handbooks and guides.

Waxwing Immigration

THE severe winter of 1946–47 was marked in England by an abnormal immigration of waxwings (*Bombycilla garrulus*) and great grey shrikes (*Lanius excubitor*), particularly the former. Appearing near Edinburgh in November, flocks of waxwings quickly spread over the eastern counties of England in the latter months of 1946, and in late December appeared in Lakeland, where some flocks of more than twenty birds were noticed. In December and January several birds appeared in Lancashire and Cheshire, near Lancaster, Liverpool, Altrincham and Chester, and as usual in these immigrations the birds were attracted to berry-bearing shrubs and were exceedingly tame. There was a previous immigration of these noticeably brilliant birds into the eastern counties early in 1943; but they do not usually penetrate in such large numbers as occurred during the recent immigration into the western half of Britain. Nesting in North Europe, their irregular visitations to Britain were first recorded near York in 1681 (*Phil. Trans. Roy. Soc.*). Odd birds occur almost every winter in Scotland, but Irish records are much fewer than those in England.

Proceedings of the Tenth International Congress of Chemistry

THE full *Proceedings of the Tenth International Congress of Chemistry*, which was held in Rome in May 1938 under the presidency of the late Prof. Nicola Parravano, were published in five volumes in Italy during the years 1938–39. Owing to the outbreak of war, many libraries in Great Britain and elsewhere will have failed to receive complete sets of this important publication, and they will be glad now to learn that copies of the five volumes are still available. Full particulars may be obtained from Prof. Guido Bargellini, Istituto Chimico, Città Universitaria, Rome, to whom also orders for any of, or all, the volumes should be addressed.

Lord Kelvin and the British Metrical System

ON June 2, 1897, in his well-known address to the Victoria Institute on "The Age of the Earth", Lord Kelvin said: "I must first ask you to excuse my giving you all my depths, heights, and distances, in terms of the kilometre, being about six-tenths of that very inconvenient measure the English statute mile, which with all the other monstrosities of our British metrical system, will, let us hope, not long survive the legislation of our present Parliamentary session destined to honour the sixty years' Jubilee of Queen Victoria's reign by legalising the French metrical system for the United Kingdom". The Weights and Measures (Metric System) Act was passed, and it is no longer a punishable offence for a tradesman to have in his possession a weight or measure of the decimal system. But with all the "monstrosities of our British metrical system" still surviving, it is interesting to recall the fiftieth anniversary of Lord Kelvin's unfulfilled hope.

Announcements

DR. T. F. WEST, author of papers on D.D.T., has been appointed an assistant director of the Ontario Research Foundation, and will leave London to take up his duties in Canada in July.

DR. D. W. DAVISON, of the physics staff of the Brown–Firth Research Laboratories (Thos. Firth and John Brown, Ltd., Sheffield), has been appointed a senior research officer, Council for Scientific and Industrial Research, Australia, in the Research School of Metallurgy at the University of Melbourne, where he will join a team working on the physics and crystallography of ferrous and non-ferrous metals, under Prof. J. Neill Greenwood.

SIR ROBERT ROBINSON, president of the Royal Society, will open a new research laboratory in the Department of Chemistry, University of Glasgow, on June 25; the laboratory is to bear the name of G. G. Henderson.

As a result of a meeting of mycologists and plant pathologists at the Indian Agricultural Research Institute, New Delhi, on February 28, the Indian Phytopathological Society was initiated. All persons interested in the study of fungi, bacteria and viruses are invited to join the Society. Further information can be obtained from the Secretary-Treasurer, Indian Phytopathological Society, Agricultural Research Institute P.O., New Delhi.

THE report of the Conference on "Research and the Smaller Firm" arranged by the Manchester Joint Research Council last October (see *Nature*, 158, 638; 1946), which has now been published (from the Manchester Chamber of Commerce. 2*s*. 6*d*.), includes an account of the proceedings of the Conference with a full report of the discussions at both sessions. The papers by Mr. C. E. Renold, Dr. C. J. T. Cronshaw and Dr. F. C. Toy are appended, with written contributions from Mr. H. Downs and Mr. J. Williams and a note on the Manchester Federation of Scientific Societies.

DETAILS of the Industrial Film Service of the Blackheath Film Unit (9 North Street, Leatherhead), which has already been responsible for such outstanding films as "Training of the Disabled", for the Ministry of Labour and National Service, and "Sugar Beet", for the Ministry of Agriculture, are outlined in a sixteen-page brochure issued by the Unit. The Unit is equipped and staffed to undertake the production of any type of industrial or instructional film, and can also provide a complete technical service to the film units of its clients.

THE Göteborgs Högskola has awarded the Heyman Prize (value about £700) to Börje Kullenberg, in recognition of his distinguished work in constructing the piston core-sampler, which has provided the means for a new departure in submarine geology. The piston core-sampler has proved capable of securing practically undisturbed sediment profiles up to 20 metres in length. It was used with great success on the *Skagerak* Expedition to the western Mediterranean during April–May 1946, when long cores were obtained down to a maximum depth of 3,600 m. It will be used from the coming Swedish circumnavigating deep-sea expedition with the *Albatross*. The Heyman Prize is given at intervals of three years, for literature and for science alternately. In 1941 the first science award was divided between the two eminent Swedish geologists, Helge Backlund and Lennart von Post.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Inhibition and the Polarity of the Retinal Elements

THE retinal elements in the cat's eye[1], as isolated by the micro-electrode technique, are, like those of the frog's eye[2], of three types: pure on-elements discharging merely to onset of illumination, pure off-elements inhibited by light and discharging merely to cessation of illumination, and on-off-elements combining the two properties. If a polarizing current of some 0·7–1·0 mA. is passed through the retina between electrodes stuck in vertically into the nasal and temporal cavities outside the bulb, it is possible to elicit on- and off-effects also by polarization[3]. In such experiments it is necessary always to place the micro-electrode in the same part of the retina, so as to preserve a constant relation to the polarizing source. Threshold responses to polarization can be measured with an accuracy of 5 per cent. In the following description of the polarities of the retinal elements, the terms 'cathodal' and 'anodal' refer to threshold responses at the nasal polarizing electrode.

The pure on-elements reproducing the simple receptor properties respond to cathodal stimulation with an on-effect. An increase of current strength by some 30–40 per cent is necessary to elicit the anodal off-effect (as in many peripheral nerves). The more complex pure off-elements (inhibited by light) have, however, opposite polarity. They respond to the threshold cathodal stimulation with an off-effect. Current reversal, *without increase of strength*, brings forth the anodal on-effect that light cannot elicit. The on-off-elements (80 per cent of the population[4]) respond with a threshold on-effect to either cathode or anode. Those that give cathodal on-effects respond to the anode with an off-effect; those with anodal on-effects respond to the cathode with an off-effect. The elements with anodal on-effects (cathodal 'off') are highly off-sensitive when tested by illumination (high off/on ratio); those with cathodal on-effects are mostly on-sensitive when tested by threshold illumination (low off/on ratio). Cathodal and anodal effects again occur at the same current strength. Except for the electrical symmetry of all the on-off-elements, a greater on-sensitivity thus makes them behave more like pure on-elements, and a greater off-sensitivity makes their properties exactly like those of the pure off-elements. This statement is based on measurements on 71 well-isolated on-off-elements.

In a very large material of isolated spikes the off/on ratio (to light) has varied from 0·001 to 10·000. This enormous variation is coupled with differences in colour sensitivity of the on- and off-components of the on-off-elements[4,5]. These two facts can only be explained by assuming the off-path to start in different receptors and join the direct on-path over internuncial neurones such as amacrines and horizontal cells[4]. The path that is inhibited by light and set free by cessation of illumination is therefore an indirect path to the fibre isolated by the micro-electrode. The polarization results can accordingly be explained in the following manner: the indirectly excited path turns its anode (source) towards the direct path and blocks it, with consequent release at 'off'. With respect to the polarizing electrode, this off-effect will be cathodal. Current reversal leads to indirect excitation (on-effect) at the same converging focus, because in this case the indirect path has turned its cathode (sink) towards the direct path. With respect to the polarizing electrode this means an anodal on-effect. The inner stimulus, however, is cathodal. Hence the perfect electrical symmetry. The anodal and cathodal foci may generate slow potentials of opposite sign, as in the isolated axon of *Sepia*[6], because it is well known that excitation and inhibition in the retina are accompanied by opposite slow potentials[1]. Inhibition is thus a function of the existence of an indirect path which can be picked out by its opposite polarity in the polarization test, and which responds to illumination with a block, followed by an off-effect when the light is turned away. The instantaneous character of the inhibition, when compared with excitation, is due to the rapid establishment of the electrical field in the short axons of the amacrines and horizontal cells which serve as 'internal commutators'. The on-off-elements are a mixture of direct and indirect paths and thus combine anodal and cathodal responses.

BO GERNANDT
RAGNAR GRANIT

Nobel Institute for Neurophysiology,
Karolinska Institutet,
Stockholm.
April 10.

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[1] Granit, "Sensory Mechanisms of the Retina" (Oxford Univ. Press, 1947).

[2] Hartline, *Amer. J. Physiol.*, **121**, 400 (1938).

[3] Granit, *J. Physiol.*, **105**, 45 (1946).

[4] Granit and Tansley, in the press.

[5] Gernandt, see following communication.

[6] Arvanitaki, *J. Physiol. Path. gén.*, **38**, 147 (1941–43).

Colour Sensitivity, Contrast and Polarity of the Retinal Elements

SINCE the time of Purkinje and Ritter, it has been known and often confirmed that a galvanic current passed through the eye elicits a sensation of bluish-violet when the electrode on the bulb is an anode, of greenish-yellow when it is a cathode. Kravkov and Galochkina[1] have recently shown that the anodal pole (on the eye) enhances the sensitivity to short wave-lengths and depresses that to long wave-lengths, whereas the cathodal pole has opposite effects. In view of the results on different polarity in retinal elements isolated by the micro-electrode technique, reported above[2], it was thought to be of interest to combine polarization of the retina with measurements of the colour sensitivity of such elements. The micro-electrode technique and the cat's eye were used, as above[2]. The strength of the current was 1·0 mA.

The pure on-elements (cathodal 'on'[2]) responded as shown in Fig. 1. Cathodal polarization increased the sensitivity to short wave-lengths; anodal polarization caused a corresponding but smaller depression. The majority of the pure on-elements in the cat's eye are blue- and green-sensitive[3]. The pure off-elements, which have opposite polarity[2], gave an increase in the long wave-lengths during cathodal polarization, with a corresponding depression during anodal polarization (Fig. 1). The majority of these elements are actually red-sensitive[3]. The on-off-elements vary a great deal in colour sensitivity,

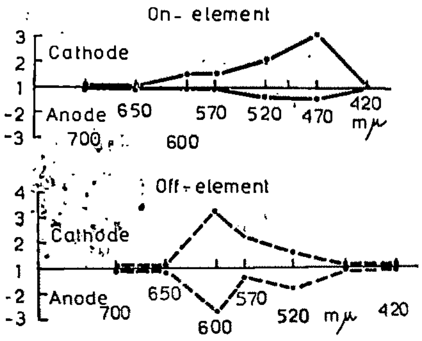

Fig. 1

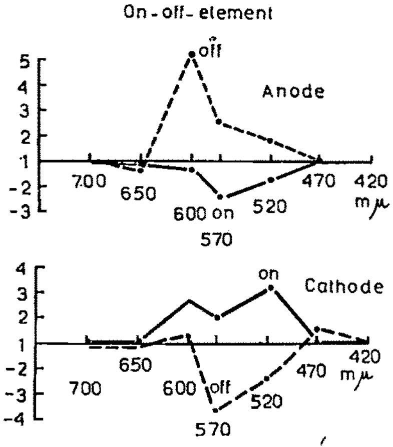

Fig. 2

Figs. 1 and 2. THE ENHANCEMENTS (POSITIVE ORDINATES) AND DEPRESSIONS (NEGATIVE ORDINATES) DURING POLARIZATION OF AN ON-ELEMENT, AN OFF-ELEMENT AND AN ON-OFF-ELEMENT AS MULTIPLES OF THRESHOLD BEFORE POLARIZATION. ABSCISSÆ: WAVE-LENGTHS

consisting as they do of narrow modulator bands in different regions of the spectrum[4]. Granit's colour work on this retina[4] was based on the on-components of these, the most common, elements (80 per cent in the cat's retina[3]). In accordance with this, the on-off-elements also responded very differently to polarization. Maxima and minima were found in various spectral regions, and sometimes they were of a very large order, for example, five times in 600 mμ in one specimen (see Fig. 2). The upper curves for this on-off-element refer to anodal polarization. The off-component had a maximum of enhancement in 600 mμ, the on-component a maximal depression in 570 mμ. During cathodal polarization (lower curves) the on-component had a maximum of enhancement in 520 mμ: the off-component a maximum depression in 570 mμ. This particular element was chosen in order to illustrate how the combination of polarization with a test of the spectral sensitivity provides a new method by means of which colour properties and the organisation of colour contrast can be clarified simultaneously. The contrast mechanism only requires that the on- and off-components of a number of elements be initiated by receptors from 'contrasting' regions of the spectrum which, even in the cat's eye, is quite often the case. Factors of great importance seem to be the off/on ratio at the threshold of illumination[3] and polarity[2].

In this first survey only the wave-lengths marked in the figure were tested on sixteen elements. The most common maxima and minima were, in 520, 600, 470, 570 mμ, in the order enumerated. Despite the limited number of wave-lengths tested, it is seen that there is good agreement with the spectral loci of Granit's modulators in the cat's eye[4]. In particular the red modulator with maximum around 600 mμ was easy to detect by this new method on account of the large enhancements and depressions that it (when present) underwent during polarization.

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April 10.

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[1] Kravkov and Galochkina, *C.R. Acad. Sci. U.S.S.R.*, **48**, No. 1 (1945).

[2] Gernandt and Granit, see preceding communication.

[3] Granit and Tansley, in the press.

[4] Granit, "Sensory Mechanisms of the Retina" (Oxford Univ. Press, 1947).

A New Protein from Ovalbumin

A few months ago when working up slops of salt-free iso-electric ovalbumin solutions from half a year of experiments, we made the surprising observation that the protein, when crystallized with ammonium sulphate, appeared as beautiful rectangular plates instead of the usual flat cigar-shaped needles. We did not at that time observe any infection of the solutions either by bacteria or moulds; but since urea was present and no antiseptics had been added, infection was a factor to be reckoned with even at the low temperature (1°) at which the protein had been stored. A further perusal of our stock of old dialysed ovalbumin solutions in the refrigerator revealed six samples, one to two years old, three of which had been stored with toluene, three without. Only the latter were infected, two with bacteria and one with moulds (and bacteria ?), and upon crystallization they gave a good (60 per cent) yield of plates. All attempts to isolate plates from the former solutions were in vain.

On the basis of these experiments it became highly probable that some—not very specific—bacterial enzyme was active in the formation of 'plate' protein. We were able to test this hypothesis by means of a dry powder of bacterial enzyme from *Bacillus subtilis*, kindly furnished us by Nordisk Insulin Laboratory. After 5 hours action of 10 mgm. of this dry powder upon 1 gm. of dialysed ovalbumin in 100 ml. water at *p*H 6·5, 0·9 gm. of the protein could be isolated as plates. At the same time, as little as 1 per cent of the protein nitrogen had become soluble in 10 per cent trichloroacetic acid. Hence it appears that we have to do with a practically complete transformation of one protein into another.

Processes of protein transformation are known from the field of enzyme chemistry; but it seems to us of considerable interest that a well-established protein like ovalbumin can be enzymatically modified without serious degradation. As mentioned above, the enzyme is scarcely specific for *Bacillus subtilis*, and investigations of different sources of enzyme, especially the hen's egg itself, are in progress. Crystalline trypsin has already been tried with negative result.

The following data concerning the process and its participants have been collected.

The enzyme (prepared from the autolysed bacteria by alcohol precipitation) is thermolabile, and is rapidly decomposed at *p*H below 4, even at room temperature. At *p*H 10 it is destroyed more slowly.

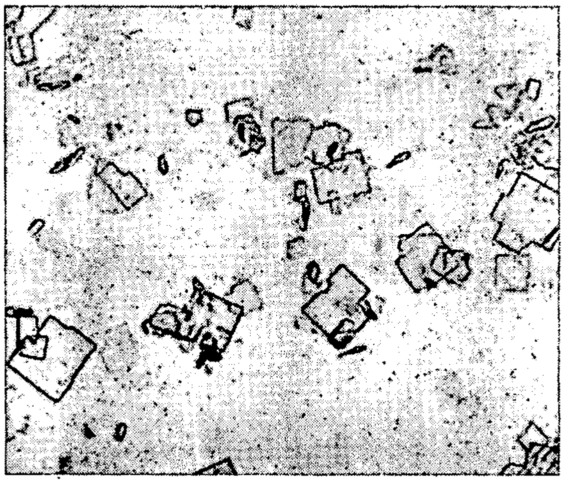

PLATE-ALBUMIN. × 475

The plate-albumin crystallizes very easily in the *p*H region 5–5·6, ammonium sulphate concentration 35–40 gm. per 100 gm. water. In mixtures with normal ovalbumin, both plates and needles will crystallize if the ratio normal/modified protein is below 0·5. The plates are markedly birefringent.

The protein seems to be much more unstable in acid solution (between *p*H 3 and 4·8) than ovalbumin, but quantitative experiments have not been carried out. It can be dialysed and recrystallized with ammonium sulphate and is extremely soluble in water (> 30 per cent). It is denatured by heat like ovalbumin.

The solubility in ammonium sulphate in the *p*H region 5–5·6 is much higher than that of ovalbumin, a circumstance that can be utilized in the determination of the amount of plate protein formed. A 1 per cent ovalbumin solution of *p*H 6·5 will give the first slight turbidity at an ammonium sulphate concentration of 37, while a similar solution of plate protein will remain clear until the ammonium sulphate concentration is 41. The table shows the results of an experiment with active and boiled enzyme (concentration of enzyme 0·01 per cent, temperature 20°).

Time (hr.)	Ammonium sulphate concentration at beginning of turbidity	
	boiled	active
0	37·0	37·5
0·5	,,	40·0
1	,,	40·6
2	,,	41·0
4	,,	41·1

As regards previous observations of a similar nature, we may refer to a paper by MacPherson, Moore and Longsworth[1], in which an ovalbumin component denoted A_2 (and characterized by its mobility in the electric field) was reported to increase in amount at the expense of another (named A_1) during storage with toluene of salt-free, iso-electric ovalbumin solutions at 4–6° for several months. It is premature to discuss the possible relation of this observation with our own. We have submitted a sample of our modified protein to Dr. Longsworth, who has kindly consented to investigate it in the electrophoresis apparatus.

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April 9.

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[1] *J. Biol. Chem.*, **156**, 381 (1944).

Urea Synthesis in Mammalian Liver

IN earlier experiments[1] it was noted that isolated rat liver can remove much more ammonia from the nutrient medium than can be accounted for by the formation of urea. We have investigated the reactions, other than urea synthesis, which cause a disappearance of ammonia in liver tissue.

The discrepancy between the amounts of ammonia removed and urea formed was especially large in homogenized liver, where the synthesis of urea was found to be virtually abolished (except when relatively high concentrations of ornithine or citrulline were added), while ammonia was still rapidly removed. The highest rates of ammonia utilization in liver homogenates were observed when α-ketoglutarate, or substances known to yield α-ketoglutarate, were present. With α-ketoglutarate the utilization of ammonia also occurred anaerobically. It was found to be accompanied under anaerobic conditions by the formation of approximately equivalent amounts of glutamic acid:

$$\alpha\text{-ketoglutarate} + NH_3 \xrightarrow{-H_2O+2H} \text{glutamic acid.} \quad (1)$$

This reaction has already been observed in extracts of liver and other tissues by v. Euler, Adler, Günther and Das[2] and by Dewan[3]. The amounts of α-ketoglutarate removed were greater than those required for reaction (1); the excess was largely accounted for by the formation of succinate and carbon dioxide. In many anaerobic experiments the data were roughly in agreement with the equation:

$$2\ \alpha\text{-ketoglutarate} + NH_3 = l(+)\text{glutamic acid} + \text{succinate} + CO_2. \quad (2)$$

Thus the reductive amination of one molecule of α-ketoglutarate is coupled with the oxidative decarboxylation of a second molecule of α-ketoglutarate. In other anaerobic experiments, the yields of succinate were considerably lower than that of glutamic acid. In these cases other oxidative reactions, in addition to the oxidative decarboxylation of α-ketoglutarate, must have taken place. Oxidations which can be coupled with reaction (1) are

$$\text{isocitrate} \xrightarrow{-2H} \alpha\text{-ketoglutarate} + CO_2$$

$$\beta\text{-hydroxybutyrate} \xrightarrow{-2H} \text{acetoacetate}$$

as was already found by Adler, v. Euler, Günther and Plass[4] and by Dewan[3].

Reaction (2) has earlier been reported to occur in *slices* of kidney and in minced heart muscle[5]; but it had not been found in slices of liver. In sliced liver, in contrast to homogenized liver, the rates of the reactions (1) and (2) are extremely slow and often negligible, $Q^{N_2}_{\text{Glutamic acid}}$ being usually less than 1 (see also Bach[6]). In rat liver homogenates $Q^{N_2}_{\text{Glutamic acid}}$ can exceed 30. The rate of reaction (1) is increased by adenosine triphosphate.

We are prompted to communicate these results at this stage because of the recent discovery by Cohen and Hayano[7] of the formation of arginine from citrulline and glutamic acid in rat liver homogenates:

$$\text{citrulline} + \text{glutamic acid} \rightarrow \text{arginine.} \quad (3)$$

Cohen and Hayano come to the conclusion that "glutamic acid appears to be an obligatory intermediate in the introduction of ammonia at the citrulline–arginine step of the urea cycle". Our results supplement the experiments of Cohen and Hayano: reaction (1) is obviously the mechanism providing the glutamic acid for interaction with citrulline.

The reaction citrulline + ammonia → arginine thus resolves itself into two stages, namely, reaction (1) followed by reaction (3).

This mechanism of arginine formation was already considered earlier[8] as a possible step in the synthesis of urea, as both reactions were known to occur in kidney cortex[7,9]; but it was rejected for liver[8] because the rates of both reactions were found to be negligible in rat liver slices. It now appears that the inability to demonstrate reactions (1) and (3) in liver slices is due to the limited permeability of the liver cells for α-ketoglutarate and glutamic acid. This is somewhat unexpected, for these two substances readily enter kidney or brain slices, to judge from their effects on tissue metabolism in slices of these tissues. In kidney cortex the rates of the reactions (1), (2) and (3) are about the same in sliced and homogenized material.

Reactions (1) and (2) also occur in pigeon liver homogenates, $Q_{\text{Glutamic acid}}$ exceeding 40. It is likely that this reaction is a link in the synthesis of hypoxanthine from ammonia in pigeon liver.

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March 13.

[1] Krebs, H. A., and Henseleit, K., *Z. physiol. Chem.*, **210**, 33 (1932), especially Table 2, p. 44.
[2] Euler, H. v., Adler, E., Günther, G., and Das, N. B., *Z. physiol. Chem.*, **254**, 61 (1938).
[3] Dewan, J. G., *Biochem. J.*, **32**, 1378 (1938).
[4] Adler, E., Euler, H. v., Günther, G., and Plass, *Biochem. J.*, **33**, 1028 (1933).
[5] Krebs, H. A., and Cohen, P. P., *Biochem. J.*, **33**, 1895 (1939).
[6] Bach, S. J., *Biochem. J.*, **33**, 1833 (1939).
[7] Cohen, P. P., and Hayano, M., *J. Biol. Chem.*, **166**, 251 (1946).
[8] Krebs, H. A., *Biochem. J.*, **36**, 758 (1942).
[9] Borsook, H., and Dubnoff, J. W., *J. Biol. Chem.*, **141**, 717 (1941).

Two Features of the *Plesianthropus* Skull

THE skull of *Plesianthropus* which we discovered on April 18 is in almost perfect condition; but being the skull of apparently a middle-aged female, some of the sutures are closed and their positions difficult to determine. Still, many can be made out. We hope within a few months to be able to send for publication a complete account of the skull; and when this is published the *Plesianthropus* skull will be almost as satisfactorily known as that of man or any of the living apes. As this complete account will probably be published to the world in less than a year, it will be unnecessary to give preliminary accounts of many of the interesting features; but there are certain points which some English anatomists consider as of very great importance, and we will give here a short account of two characters which will be sufficient to prove that *Plesianthropus* is not just a chimpanzee, but a being of considerably more importance.

Prof. Wood Jones, in his delightful book, "Man's Place Among the Mammals", devotes a few pages to the structure of the floor of the anterior fossa of the cranial cavity, and gives a number of diagrammatic drawings to show that man is in this part of his anatomy not very closely allied to the higher anthropoids, though a little more allied to the orang. In this we agree with him.

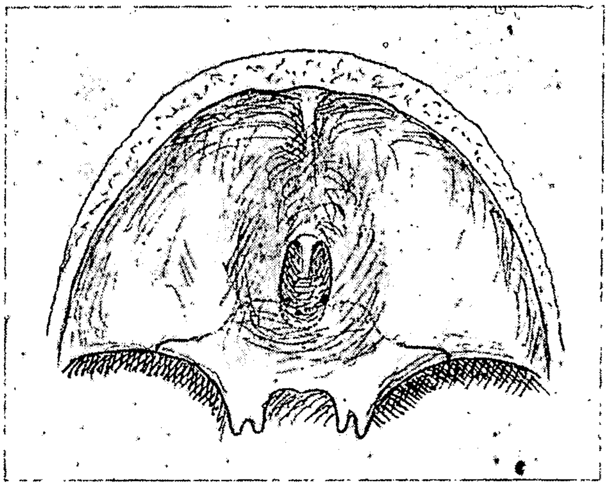

Fig. 1. ANTERIOR FOSSA OF SKULL OF *Plesianthropus transvaalensis* BROOM, ♀. ¾ NATURAL SIZE

In man the relations of the sphenoid to the ethmoid and frontals differ considerably in different specimens, but only rarely do the frontals meet behind the cribriform plate. In the gorilla and most chimpanzees, the frontals meet; but in the orang and the gibbon the sphenoid and the ethmoid usually articulate on the floor of the fossa. In most Old World monkeys the frontals also meet.

In *Plesianthropus* the condition is very similar to that in man. The fossa is large and extends much in front of the cribriform plate. The sphenoid forms a large part of the floor of the fossa. The sutures at the outer parts can be clearly seen, but cannot be determined with certainty in front. There seems little doubt, however, that the sphenoid articulates with the ethmoid, and that behind the cribriform plate the frontals are wide apart.

We have drawn the cribriform plate as it is in the specimen, and we indicate with a little hesitation what we regard as its anterior and posterior borders. There is a small but quite distinct crista galli.

An interesting point is that the lesser wings of the sphenoid with the frontals form as in man very marked outstanding bony ridges which divide the temporal fossæ from the anterior. This is a human character which we cannot match in any anthropoid skulls we have seen—gorilla, chimpanzee, orang or gibbon.

Another interesting point is the structure of the orbit. In man the inner wall of the orbit is mainly formed by the lacrimal, the frontal, the ethmoid and the maxilla, and the ethmoid has a long articulation with the lacrimal. In the higher anthropoids the frontals usually meet the maxillæ and "the planum

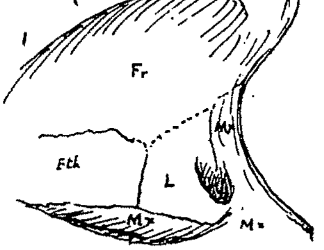

Fig. 2. INNER WALL OF THE ORBIT OF *Plesianthropus transvaalensis* BROOM. NATURAL SIZE

orbitale of the ethmoid is reduced". In the orang and the gibbon a large planum orbitale articulates in front with the lacrimal, as in man. The figure we give of the orbital wall in *Plesianthropus* shows a condition almost exactly as in man.

We are here not at present concerned with the question of whether man and the Australopithecinæ have arisen from an early anthropoid, or a pre-anthropoid, or an Old World monkey or a tarsioid; but we think the evidence afforded by this new skull of *Plesianthropus* shows that the Australopithecinæ and man are very closely allied, and that these small-brained man-like beings were very nearly human.

R. Broom
J. T. Robinson

Transvaal Museum, Pretoria.
May 26.

Conversion of Carbon Dioxide to Acetylene on a Micro Scale

As a preliminary to future attempts to synthesize, on a very small scale, biologically important compounds containing radioactive carbons C^{14} or C^{11}, we have developed a technique for the conversion of small quantities of carbon dioxide to acetylene. Both carbon isotopes[1,2] are most conveniently prepared in the chemical form of carbon dioxide, but acetylene is a better starting substance for a number of syntheses. In our experiments, pure barium metal was heated in a stainless steel vacuum furnace of special design in the presence of carbon dioxide, which was absorbed with the formation of barium carbide.

Quantities of ordinary inactive carbon dioxide varying from 50 to 500 microlitres at N.T.P. were measured in a McLeod gauge and transferred through a high-vacuum apparatus to the stainless steel furnace containing about 40 mgm. of barium metal which had been scraped as clean as possible before weighing. The furnace was heated to 600° C. for 5–10 min. and all the carbon dioxide disappeared. The furnace was cooled and its contents dissolved in water. The gas mixture obtained was found to consist (apart from water vapour and hydrogen) of acetylene, ammonia formed from barium nitride and a trace of ethylene which never exceeded 2 per cent of the total C_2 hydrocarbons.

Acetylene was separated by passing the mixture through a rough drying trap at $-78°$ C. and then adsorbing ammonia, water vapour, acetylene and the trace of ethylene from the hydrogen stream on to active charcoal at $-78°$ C., the hydrogen being pumped away. The temperature of the charcoal was raised to 0° C., when an appreciable proportion of the acetylene (and ethylene) was desorbed: the acetylene was finally condensed into a trap connected with the McLeod gauge. No ammonia or water vapour is desorbed at this temperature during the ten minutes necessary for practically all the acetylene to be recovered.

The results were as follows:

Expt. No.	Carbon dioxide used (μl. at N.T.P.)	Acetylene (+ ethylene) found (μl. at N.T.P.)	Acetylene blank (μl. at N.T.P.)	Yield %
21	335	178	14	98
22	273	133	12	89
23	300	140	3	91
24	305	140	3	90
*25	62	25·5	1·1	79
27	558	265	3	94
28	566	260	2	91
*29	50	21·5	1·8	79

* From these and other experiments it appears that lower yields for small quantities of CO_2 are to be expected.

Stainless steel was found to be the most satisfactory furnace material tried. From mild steel relatively large amounts of acetylene were produced in blank experiments, and a fused silica envelope fitted with a nickel thimble was found, after it had been used with calcium and barium metals, to absorb carbon dioxide when hot even when no calcium or barium was present. In carrying out the absorption of carbon dioxide by barium metal in the stainless steel furnace it was found that when the pressure at which the gas was admitted was less than about 10^{-1} mm. of mercury, the yield of acetylene was variable and only about 45 per cent. Good yields were obtained when the carbon dioxide at its full pressure was admitted to the furnace before raising the temperature above 400° C. It was further found that if acetylene, ammonia and water are condensed together in the presence of mercury, acetylene is lost very rapidly on warming up the mixture. This may be due to the formation of mercury acetylide. Losses due to all the above causes are avoided by following a standard procedure.

For the identification of all the gases involved in these experiments, physical and chemical methods were applied. Vapour pressures at low temperatures were measured, and individual gases were absorbed from mixtures with standard reagents. Acetylene in particular was absorbed in a paste of cuprous chloride and caustic potash solution with the formation of red copper acetylide.

The conversion of carbon dioxide to acetylene can be carried out in about half an hour. This may make possible the synthesis of many compounds containing C^{11} of half-life 20·5 min.

Full experimental details of this work will be published elsewhere.

We wish to thank Prof. W. H. Linnell for his interest and support, many others for helpful conversations, the Research Laboratories of the General Electric Co., Ltd., for a specimen of very pure barium metal, and to acknowledge generous grants from the Therapeutic Research Corporation, the Royal Society, the Medical Research Council and the Central Research Fund of the University of London. One of us (R. G.) is a Keddey Fletcher-Warr student of the University of London.

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March 26.

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[2] Yost, Ridenour and Shinohara, *J. Chem. Phys.*, 3, 133 (1933).

A New Indicator for Iodometric Analysis

It is well known to analysts that starch is very far from being an ideal indicator for iodine, and the disadvantages from which it suffers are not all avoided by the use of an acid-solubilized starch. It will be agreed that the chief disadvantages attending the use of starch are: (1) the insolubility of starch in cold water; (ii) the instability of starch dispersions in water, in consequence of which a stock solution soon deposits a flocculent precipitate of retrograded starch; (iii) that starch gives with iodine a water-insoluble complex, the formation of which precludes the addition of the indicator early in the titration;

and (iv) the 'drift' of end-point which is particularly marked when the solutions used are dilute.

In the course of our investigation of the glycollic ethers of starch and of its components, amylose and amylopectin, we encountered a derivative which has proved to be eminently suitable as an indicator in iodometric titrations. This derivative is the sodium salt of a starch glycollic acid in which the ratio, glycollic acid units/glucose units, is approximately 1 : 10. This derivative, which is conveniently described as 'sodium starch glycollate (1 : 10)', has almost the same iodine-staining power as starch itself, and as an iodometric indicator it possesses none of the disadvantages mentioned above. It is a non-hygroscopic white powder which dissolves, with ease, in cold water to give a clear solution. The only factor limiting the concentration obtainable in cold water is the viscosity of the resulting solution. The solutions are completely stable, no retrogradation occurs, and they may be kept for months without the faintest turbidity appearing. The glycollate does not form a water-insoluble complex with iodine, and in consequence the indicator may be added at any stage in a titration. The end-point is very sharp: with an excess of iodine (as at the beginning of a titration with thiosulphate) the colour of the solution is green, and as the titration proceeds and the iodine concentration diminishes, the colour changes gradually to pure blue, which becomes intense just before the end-point is reached. The end-point is sharply reproducible and no drift is observed even in highly dilute solutions.

Sodium starch glycollate maintains its superiority over starch as an indicator in all the types of iodometry examined, as, for example, in the estimation of reducing sugars by the Shaffer–Hartmann or Somogyi methods or in the estimation of copper or arsenic.

Preparation. A dispersion of starch (10 gm.) in water (160 c.c.) is stirred with 50 per cent sodium hydroxide solution (30 c.c.), and to the mixture is slowly added sodium monochloroacetate (5 gm.) in water (20 c.c.) at 50° C. After neutralization with acetic acid, the solution is dialysed for three days in a 'Cellophane' bag against running water. Thereafter, the sodium starch glycollate is precipitated from solution by the addition of an excess of alcohol, and its purification completed by its extraction in a Soxhlet apparatus with water-alcohol (10 : 90 by volume). The glycollic acid content is estimated by precipitation of either the copper or the silver salts.

We wish to record our thanks to Lieut.-Colonel F. W. Pinkard, who carried out most of the comparative iodometric titrations.

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Metal–Ammonia Solutions

A solution of sodium in liquid ammonia is known[1] to give a eutectic, m.p. −110° C. We have now determined the melting points for the eutectic of potassium, ~ −157° C.; of lithium, ~ −185° C., and of calcium, ~ −90° C. The solids separating from the frozen eutectic solutions of potassium and sodium are undoubtedly ammonia and the metal; the latter can be seen as silvery crystals. From frozen calcium solutions a brass-like solid separates, which certainly contains the hexammoniate known to be stable even at room temperature[2]. From the lithium solution a similar solid is obtained, and it therefore seems probable that it also forms an ammoniate. A resemblance between calcium and lithium can also be found in the short time (small amount of heat) required in both cases to melt the eutectic compared with that for sodium or potassium. This is understandable if one remarks that the heat taken up in the process goes chiefly in melting ammonia (which has a very high latent heat), since this, in the ammoniates, is already associated to some extent with the metal, and very little extra is required to form the eutectic solution. The resemblance extends to chemical reactions, since a concentrated solution of lithium in ammonia, which is stable and has a very low vapour pressure at room temperature, can be used to hydrogenate benzene rings, and exerts some demethylating effect on methoxyalkylbenzenes (compare calcium hexammoniate)[3].

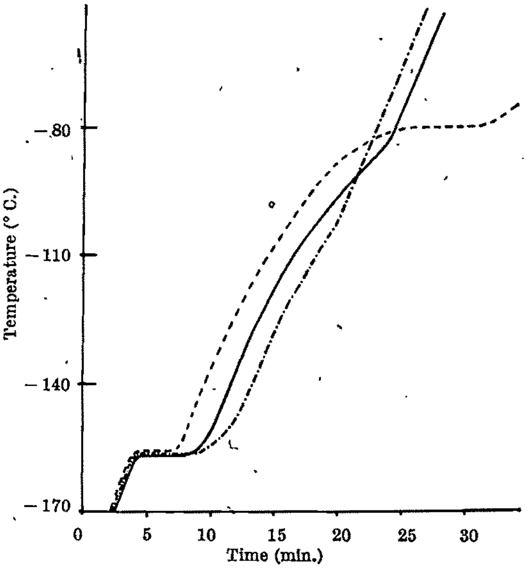

Fig. 1. Potassium–ammonia solutions. Experimental points, all at ½-min. intervals, lie closely on curves and have been omitted for clarity. – – –, 6·3 atomic %; ———, 11·8 atomic %; —·—·—, 14·3 atomic %

The constitution of the ammoniates, which have metallic properties, is not clear. It seems probable that they are lattice 'compounds', and the ammonia is not necessarily bound by complete electronic bonds. Their non-formation with potassium and sodium may be due to inability to form a suitable lattice; but from the similar appearance and behaviour of the solid ammoniates and the very concentrated solutions of all the metals, it is probable that strong association between ammonia and the metal takes place even in the liquid. This would explain the extremely sharp drop in the vapour pressure of solutions as the concentration approaches that of the eutectic. This drop is manifested as a very great depression of the melting point of solid ammonia in contact with the solution. We have been able to construct the portion of the phase curve for concentrated solutions (below the melting point of pure ammonia) from the warming curves (Fig. 1), which show a slight, but easily discernible, rise in slope at the point where the solid ammonia finally disappears, the curve hereafter becoming practically a straight line. This portion of the phase curve represents the solubility of ammonia in the metal.

The upper flat step in the warming curve for dilute solutions represents the melting point of solid ammonia at a temperature which remains constant because of the appearance of two liquid phases of fixed concentrations. This phase separation is well known for sodium[1] and calcium[2]; our results confirm it for potassium with an upper consolute point at ~ −74° C., but show that it is very unlikely for lithium. Kraus[4] has stated that the deviations of the vapour pressure of the solutions from Raoult's law (shown diagrammatically in Fig. 2) arise as a result of the phase separation, and not as a result of aggregation of the solute. It is clear, however[5], that the phenomenon of separation into two liquid phases in equilibrium is to be regarded as a direct consequence of the deviations from Raoult's law. Bowden has pointed out: "this is reminiscent of the van der Waals p—v curve . . ." It appears to us that, in fact, a first quantitative approximation may be derived by using the van der Waals' modification of Boyle's law in Van't Hoff's law of osmotic pressure, deriving the constants in the equation from known data at the upper consolute point. The existence of associative forces would be expected to lead to aggregation of the solute molecules, and this is shown even at the boiling point by an apparent rise in molecular weight for increasing concentrations above a low value. If this association were great enough, it could explain the rise in vapour pressure in the intermediate region which would occur in absence of liquid-liquid phase-separation, and which does, in fact, produce the separation into a more concentrated and a more dilute phase. The rapid fall near the eutectic concentration can be attributed to almost complete binding of the ammonia.

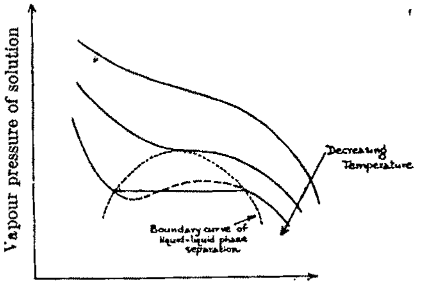
Vapour pressure of solution
Decreasing Temperature
Boundary curve of liquid-liquid phase separation
Concentration

Fig. 2

It would appear that similar phenomena should occur with the other alkali and alkaline earth metals. A more detailed discussion of this work will be published elsewhere.

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[1] Ruff and Zedner, *Ber. deutsch. chem. Ges.*, **41**, 1948 (1908).

[2] Kraus, *J. Amer. Chem. Soc.*, **30**, 653 (1908).

[3] Birch, *J. Chem. Soc.*, 593 (1946).

[4] Franklin and Kraus, *Amer. Chem. J.*, **20**, 850 (1898).

[5] See, for example Bowden, "The Phase Rule and Phase Reactions", 131 (Macmillan, London, 1945).

Isomorphic Form of Urea Picrate

Urea picrate is described by Smolka[1] as having m.p. 142° C. and formula $CH_4ON_2,C_6H_3O_7N_3$ (form *A*). A new isomorphous form with m.p. 275° C., and the same formula (form *B*) is here described.

Preparation. Form *A* is prepared by mixing solutions of urea and picric acid. Although various solvents—water, acetone and methyl, ethyl and *n*-propyl alcohols—have been tried, in every case form *A* was precipitated. 4 : 1, 1 : 1, and 1 : 4 molar ratios of urea and picric acid were also tried. Again form *A* was always precipitated.

Form *B* may be prepared in two ways: (*a*) Repeated recrystallization. After several recrystallizations from alcohol, the melting point of form *A* is raised to 170° C. or higher. One or two further recrystallizations then raise the melting point to about 255° or 260° C. (*b*) Chromatography. If an alcoholic solution of form *A* is passed down a sand column and then concentrated, the resulting crystals usually melt well above 200° C. A further recrystallization is usually sufficient to raise the m.p. to 255°–260° C. In these preparations of form *B*, two points are noteworthy. Once the melting point is raised above *c.* 170° C., little difficulty is experienced in raising it to 255–260° C. Several further recrystallizations are necessary to raise it to 275° C.

Crystallography. Crystals of both forms were examined by Dr. C. O. Hutton, of the Geology Department here. He reports that while form *A* is monoclinic or possibly triclinic, form *B* is orthorhombic.

Analysis. Analytical figures obtained were as follow:

Found	C, 29·1% ;	H, 2·58% ;	Urea N, 9·7, 9·7, 9·9, 10·1%
Calc. for			
$CH_4ON_2,C_6H_3O_7N_3$	29·1	2·42	9·7
$CH_4ON_2,2C_6H_3O_7N_3$	30·1	1·93	5·4

Kjeldahl analyses for total nitrogen even on the same sample gave results ranging from 21 to 24 per cent. While the carbon and hydrogen values agree closely with those calculated for $CH_4ON_2,C_6H_3O_7N_3$, since the figures for the two formulæ are so close, urea nitrogen was estimated by the urease method.

The unreliability of the melting points of picrates is notorious. The case of urea picrate is just another example. It is felt that to prevent others being led astray, this abnormality should be reported.

I have to thank Mr. C. L. Carter, senior lecturer in chemistry at the University of Otago, for the micro-determination of carbon and hydrogen.

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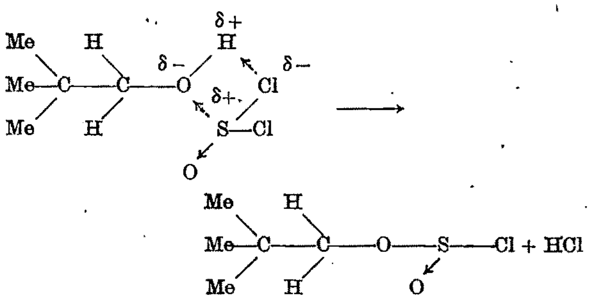
[1] Smolka, *Monatsch.*, **6**, 915 (1885); *Brit. Chem. Abs.*, **50**, 453 (1886).

Neo-pentyl Alcohol and Steric Hindrance

Whitmore and Rothrock[1] showed that the hydroxyl group in *neo*-pentyl alcohol has remarkable resistance against replacement by a halogen atom through the agency of thionyl chloride and phosphorus tribromide. Dostrovsky, Hughes and Ingold[2] attribute this to steric hindrance to 'end-on' approach to the α-carbon atom. Whitmore and Rothrock, however, leave the impression that *neo*-pentyl alcohol does not interact at all with these reagents, and indeed state: "The inactivity of neopentyl alcohol to heat and reagents has been demonstrated"; but the work of Gerrard[3] enabled us to predict probability of easy 'broadside' approach.

neo-Pentyl alcohol and thionyl chloride quite readily gave us the chlorosulphinate, ROSOCl, and in the presence of pyridine, the sulphite, R_2SO_3, in excellent yields. Phosphorus trichloride, and tribromide in the absence of pyridine, produced the halogenophosphites, for example, ROPCl$_2$, while in the presence of pyridine, an *ester* of phosphorous acid was readily obtained. Phosphorus oxychloride in the presence of pyridine gave an *ester* of phosphoric acid. We conclude that *neo*-pentyl alcohol very readily responds to 'broadside' four-centre attack; for example:



We find that the hydroxyl group in αα-dimethyl-*neo*-pentyl alcohol, a tertiary alcohol, is replaceable by halogen through the interaction with these reagents, in accordance with the theory of substitution developed by Ingold and Hughes.

Details of these experiments are being prepared for publication.

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March 27.

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[1] Whitmore and Rothrock, *J. Amer. Chem. Soc.*, 54, 3431 (1932).

[2] Dostrovsky, Hughes and Ingold, *J. Chem. Soc.*, 173 (1946).

[3] Gerrard, *J. Chem. Soc.*, 688 (1936); 99 (1939); 218 (1940); 85 (1944).

Precipitating Effect of Cationic Detergents on Soluble Starch

CATIONIC detergents, the bactericidal property of which was discovered by Domagk (1938), have a precipitating effect on certain proteins (Kuhn–Bielig, 1940). Since this precipitation occurs at high pH values, it is evident that it is due to salt-like bonds between the positively charged groups of the detergent and negative groups of the proteins. It is not surprising, therefore, that similar precipitates were observed when solutions of polysaccharidic acids, such as agar-agar, heparin, or gum arabic, were added to those of 'Desogen' (Geigy), that is, methyl-phenyl-dodecyl-trimethyl-ammonium methosulphate. In the course of these experiments it was observed, however, that polysaccharides *devoid of acidic groups* were also precipitated by 'Desogen'. Thus soluble starch (Merck, Schuchardt), dissolved in distilled water or in salt solution at different pH values, gave distinct precipitates. Two minima of turbidity were observed, one at a pH of 14 and another close to pH 7 (see table).

Each of the test tubes used in this experiment contained 160 mgm. of soluble starch, 40 mgm. of 'Desogen' and 20 ml. of 0·1 M borate buffer solution. The intensity of the turbidities was measured nephelometrically. Then the precipitate brought about at a pH of 9·2 was centrifuged, dried and weighed. The quantity of the other precipitates was calculated by comparison of this value with the nephelometric values.

pH values:	0(=N HCl)	1	2·3	6·5	8·2	9·2	11	14(=0·1 N NaOH)
Precipitates (mgm.):	36·6	23	4·6	5·5	34	50	52	8·8

When starch and 'Desogen' were dissolved in distilled water, the amount of precipitate was negligibly small; a distinct precipitate was observed in isotonic and hypertonic solutions of sodium chloride.

The amount of precipitate depends on the relative concentration of both components. Maximal precipitates were obtained with mixtures containing 20 mgm. of 'Desogen' with 80 mgm. of soluble starch in 10 ml. of the buffer solution. The turbidity and the precipitates began to disappear when the solutions were heated to 30–40°, and the solutions became entirely transparent at 70°; on cooling, the precipitate appeared again. Moreover, we observed that the colour reaction of soluble starch given by iodine was inhibited by 'Desogen'. The blue colour was changed to a reddish-violet or to a pale yellow, depending on the amount of 'Desogen' added to the starch solution.

The details of these and other experiments will be published elsewhere.

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Muscle-Relaxing Ethers of Glycerol

THE discovery of the useful applications of curare in medicine and surgery has directed attention to other substances which are capable of producing muscular relaxation in man. In 1910, Gilbert and Descomps[1] administered the α-phenyl ether of glycerol to guinea pigs and observed: "Au bout d'un laps de temps variant, suivant la dose injectée, de trois minutes à dix minutes, on voit apparaître un certain degré de parésie des membres, parfois précédée de quelques rares et courtes contractures passagères. Cette paralysie incomplète est toujours transitoire, et sa durée oscille en général entre quinze et trente minutes; une seule fois, elle persista une heure." Launoy[2] studied the action of the same compound and observed a "résolution musculaire" and the antagonism of the drug to strychnine. Muscle-relaxing properties were later and independently observed in several glycerol ethers[3], and one of these, the α-*o*-tolyl ether ('Myanesin'), was found to be effective in man[4]. The present note indicates some of the relationships which have been observed between the molecular structure of glycerol ethers and their muscle-relaxing power. For the purpose of discussion it is useful to consider the molecular median paralysing dose ($P.D._{50}$/mol. wt.) in mgm. per kgm., that is, the mole-fraction of the glycerol ether which is required to paralyse 50 per cent of white mice to which it has been administered subcutaneously.

The presence of the grouping —O—CH$_2$—CROH—CR_2OH appears to be necessary for muscle-relaxing activity. Most of the β- and γ-alkyl derivatives of the α-ethers that we have tested are relatively inactive, as also are a few O-glucosides of active glycerol ethers. Some esters show activity of a low order, but this may be due to hydrolysis following injection. The activity of the α-ethers, *R*O—CH_2—CHOH—CH_2OH, varies greatly with *R*. Beginning with the simplest compounds, the activity increases to a maximum with the introduction of additional groups and then falls. Before maximum activity has been reached, both the nature and orientation of groups are prominent factors in determining activity; but afterwards the introduction of additional substituents causes a fall in potency, and the extent of the change is no longer so characteristic of the added group.

The methyl and ethyl ethers show negligible activity. With increase in chain-length the activity increases to a maximum at C_5 and then falls. The *iso*-butyl and the *iso*-amyl ethers are weaker than their *n*-isomerides in approximately the same degree.

	$P.D._{50}$/mol. wt. × 10^2
Methyl	>2·4
Ethyl	>2·1
Propyl	>1·5
Butyl	1·0
Amyl	0·57
iso-Butyl	1·2
iso-Amyl	0·81

The phenyl ether is more active than any of the alkyl ethers mentioned.

In the aryl series an increase in activity follows the introduction of a single methyl, ethyl, allyl, chloro or bromo substituent, the effect depending on the group and its orientation.

	$P.D._{50}$/mol. wt. × 10^2
Phenyl	0·54
o-Tolyl	0·18
m-Tolyl	0·32
p-Tolyl	0·29
p-Chlorophenyl	0·22
p-Bromophenyl	0·34

In the *p*-alkyl series maximum activity occurs in the *p*-tolyl compound. Each successive addition of —CH_2— reduces the activity by an approximately constant amount.

	$P.D._{50}$/mol. wt. × 10^2
p-Ethylphenyl	0·43
p-Propylphenyl	0·61
p-Butylphenyl	0·80

In the *o*-series, the allyl compound is more effective than the propyl. The activity of each is increased slightly by an additional *o*-methyl substituent, but a *p*-methyl reduces the activity of both in approximately the same degree.

	$P.D._{50}$/mol. wt. × 10^2
2-Propylphenyl	0·58
2-Propyl-4-methylphenyl	0·83
2-Propyl-6-methylphenyl	0·49
2-Allylphenyl	0·35
2-Allyl-4-methylphenyl	0·63
2-Allyl-6-methylphenyl	0·31

Chlorine and bromine, which as single substituents increase the activity of the α-phenyl ether, both decrease the activity of the *o*-allylphenyl and *o*-propylphenyl ethers, and the effect is largely independent of the nature of the halogen or its orientation.

	$P.D._{50}$/mol. wt. × 10^2
2-Propyl-6-chlorophenyl	0·78
2-Propyl-6-bromophenyl	0·48
2-Propyl-4-chlorophenyl	0·85
2-Propyl-4-bromophenyl	0·86
2-Allyl-6-chlorophenyl	0·55
2-Allyl-6-bromophenyl	0·59
2-Allyl-4-chlorophenyl	0·58
2-Allyl-4-bromophenyl	0·58

The above discussion is based on the work of our colleagues, Messrs. B. Baker, N. A. C. Pryce, F. G. Sayer, Miss M. Gayler and Drs. Elliott, Forrest, Maclean and Stephenson.

We desire to express our thanks to the directors of the British Drug Houses, Ltd., for permission to publish this note.

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April 3.

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[1] Gilbert and Descomps, *C.R. Soc. Biol.*, **69**, 145 (1910).

[2] Launoy, *C.R. Soc. Biol.*, **69**, 191 (1910).

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A Recording Surface Balance of the Horizontal Type

A SIMPLE and robust film-pressure meter has been constructed using the principle of the 'Mikrokator'[1,2]. The new instrument has been evolved in collaboration with the inventor of the 'Mikrokator', Mr. H. Abramson, of Messrs. C. E. Johansson, Eskilstuna, Sweden, and is a modification of the standard length-measuring instrument manufactured by that firm.

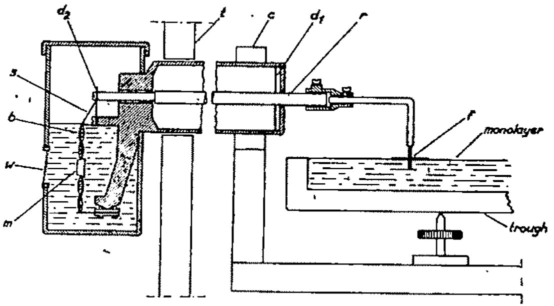

Fig. 1

The construction of the pressure meter is shown in Fig. 1. The pressure to be recorded is applied to the free (right) end of the rod *r*. In the figure a mica float *f* is attached directly to the end of *r*, but other arrangements for transferring the film pressure to the rod may, of course, be used. The rod *r* is supported by two thin slotted steel diaphragms d_1 and d_2. At the left end of *r*, the spring *s* transfers the axial movement of the rod to one end of a thin, spirally twisted, perforated metal ribbon *b*, the lower end of which is fixed. Before mounting in the instrument, the ribbon is placed between fixed supports and the mid-point turned until a desired permanent twist persists. In the instrument, the alteration of the distance between the supports resulting from axial displacement of *r* causes the mid-point of the ribbon with the attached mirror *m* to turn. The mirror moves in a Nujol bath which gives suitable damping. Over the small range of angular deflexion used (about 3°), the movement of the mirror is accurately proportional to the film pressure. There is no friction, and owing to the high mechanical magnification of the instrument the axial movement of *r* with the attached mica float *f* for full-scale deflexion is very small.

In the instrument now in use, which has a range of 60 dynes per cm. and a period of 0·3 sec., this movement is of the order of 0·1 mm. only. The stem of the 'Mikrokator' is held by a clamp *c* (this clamp is attached to the carriage of the recording Wilhelmy – Dervichian balance previously described[3]), and passes through a hole in the wall of the thermostat *t*. The light from a straight-filament lamp is reflected from the mirror *m* and focused on to a cylindrical recording camera which is driven synchronously with the film-compressing barrier by means of a hydraulic drive mechanism (cf. ref. 3). The zero position of the instrument, which is very stable, can be altered by means of an adjustable spring (not shown in Fig. 1) attached to the left end of the rod *r*. The calibration of the instrument may be carried out with an auxiliary torsion balance or by means of films showing distinct phase transitions at known surface pressures. It is possible to construct instruments having a much higher sensitivity than that mentioned above.

The 'Mikrokator' surface balance is at present being used to study phase transitions in condensed monolayers, especially the reversibility of the phase changes on expansion of the film. The vertical type balance is in general not suitable for the study of the behaviour of monolayers on expansion, and we have also encountered certain difficulties, even when using an instrument with symmetrical compression[4], in the study of transitions to the solid *CS* phase in cases when the L'_2 phase is absent, for example, with normal chain primary alcohols, methyl and ethyl esters of normal chain carboxylic acids (for a description of the surface phases found for condensed films of long-chain carboxylic acids see ref. 4).

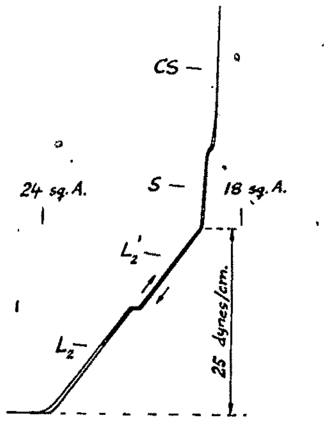

Fig. 2

As an example of the use of the 'Mikrokator' balance, a compression-expansion run of *n*-docosanoic (behenic) acid spread on 0·01 *N* hydrochloric acid at a temperature of 15·2° C. is shown in Fig. 2. The reversibility of the three different phase transitions and of the pressure-area curve in general is clearly demonstrated. In order to obtain curves of the type shown in Fig. 2 the hydraulic drive mechanism previously used[3] had to be redesigned to allow movement of barrier and camera in either direction.

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[3] Andersson, K. J. I., Stållberg-Stenhagen, S., and Stenhagen, E., "The Svedberg 1884 30/8 1944", 11 (Uppsala, 1944).

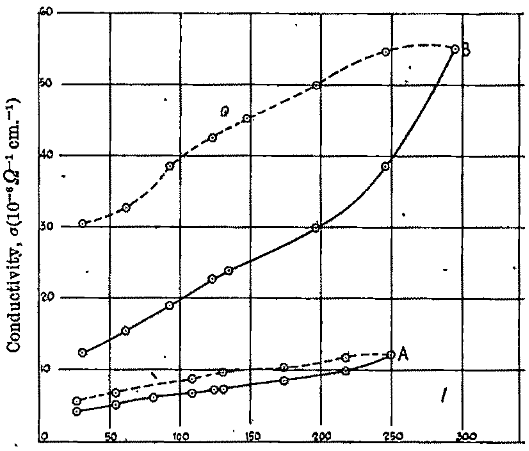
[4] Ställberg-Stenhagen, S., and Stenhagen, E., *Nature*, 156, 239 (1945).

Conductivity Hysteresis of Dust Deposits

THE electrical breakdown of a gap bridged by dust deposits is frequently ascribed to the presence of the dust, but little information on the conductivity characteristics of dust is available. These characteristics were therefore investigated for a typical sample of the following composition: volatile matter (oils), carbon, moisture, 55 per cent; metals and oxides (iron, copper, brass, iron and copper oxides), 36 per cent; residue, complex silicates (clay), 9 per cent.

A conductivity cell of the type described by Maurer[1] was used, and measurements were carried out with the dust compressed to varying degrees corresponding to different conditions of sedimentation.

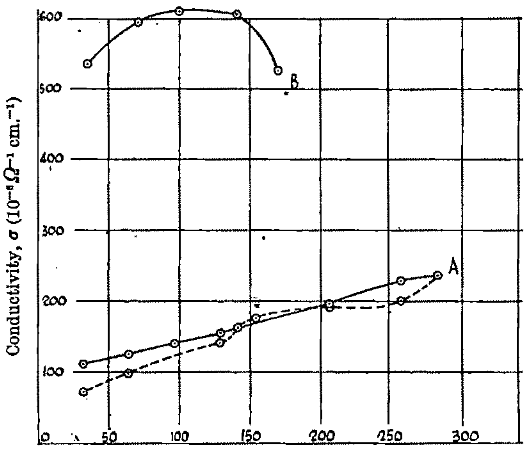
The results are shown in Figs. 1 and 2. Under compressions of the order of 10 lb./sq. in. and 50 lb./sq. in., the dust behaves initially as a symmetrical semi-conductor with the conductivity σ increasing with the applied potential gradient ΔV, according to an empirical expression $\sigma = \beta \Delta V^{\alpha}$ which is derived from a power law proposed by Fairweather[2], α being a constant of the material and β a conductivity factor. Above a critical value of ΔV, σ rises more rapidly. The conductivity characteristic becomes



Potential gradient, ΔV (peak A.C. volts/cm.)

Fig. 1. CONDUCTIVITY HYSTERESIS OF A DUST SAMPLE

Compression: *A*, 10 lb./sq. in.; *B*, 50 lb./sq. in. ΔV increasing, ——— ; ΔV decreasing, - - - -



Potential gradient, ΔV (peak A.C. volts/cm.)

Fig. 2. RELATION BETWEEN CONDUCTIVITY AND APPLIED POTENTIAL GRADIENT OF DUST UNDER HIGH COMPRESSION

Compression: *A*, 100 lb./sq. in.; *B*, 200 lb./sq. in. ΔV increasing, ——— ; ΔV decreasing, - - - -

non-reversible in this region, and decrease of ΔV then leads to conductivity hysteresis. This effect is independent of the direction of ΔV, and thus occurs with both A.C. and D.C. potentials.

Güntherschulze[3] has explained semi-conductivity for 'Silit', a mixture of silica-carbide, graphite and alumina, on the basis of electron acceleration in the nominally insulating particles of alumina, the penetration involving larger particles with increasing ΔV. This mechanism can be applied to compressed dust, which forms a similar material. Fröhlich[4] has shown that, if the dielectric stress on such particles exceeds a critical value, their insulating properties will be destroyed entirely, and the conductivity of a given path thus increased. Dielectric breakdown increases cumulatively with time; but if ΔV is reduced below its critical value after, say, one minute, sufficient nominally insulating particles are left to restore normal semi-conductivity at a higher level. The empirical equation also applies for decreasing values of ΔV. α is not affected by hysteresis, and varies only slightly with increasing compression, but β increases with hysteresis by 32 per cent at 10 lb./sq. in. (Fig. 1, Curve *A*) and by 124 per cent at 50 lb./sq. in. (Fig. 1, Curve *B*), and with compression by 150 per cent between 10 lb./sq. in. and 50 lb./sq. in.

Dèchêne[5] has reported a decrease of contact resistance between particles with increasing compression. This gives rise to a reduced interfacial contact potential and a larger potential gradient across insulating layers, which leads to a more pronounced hysteresis at 50 lb./sq. in. (Fig. 1, Curve *B*). But at high values of compression, conduction tends to become predominantly metallic. The leakage currents are then sufficiently large to cause considerable heating in the sample, and the positive temperature coefficient of the metallic conductors gives rise to a somewhat erratic hysteresis effect at 100 lb./sq. in. (Fig. 2, Curve *A*), and to a falling conductivity at higher values of ΔV at 200 lb./sq. in. (Fig. 2, Curve *B*).

Conductivity hysteresis is thus dependent on the compression of the dust, and it reaches a maximum at a condition of sedimentation which may well be found in dust deposits containing oil and moisture and subjected to intermittent vibration.

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[2] Fairweather, A., *J. Inst. Elect. Eng.*, **89** (I), 499 (1942).

[3] Güntherschulze, A., *Z. phys.*, **86**, 778 (1933).

[4] Fröhlich, H., *Nature*, **158**, 332 (1946).

[5] Dèchêne, G., *C. R. Acad. Sci. Paris*, **200**, 648 (1935).

Nuclear Thermodynamics and Showers

THE properties of a thermodynamic assembly consisting of atomic nuclei, nucleons, electrons and positrons, at high densities and at temperatures for which $kT \sim mc^2$ (m being the electron mass), have been studied by several investigators[1]; but the application of the results to the problem of the relative abundances of atomic nuclei in the universe has so far met with little success. It is generally recognized, however, following Bohr, that thermodynamical concepts provide a useful basis for discussing the general features of nuclear phenomena.

The purpose of this communication is to point out the possible bearing of the study of such dense, high-temperature assemblies on the phenomenon of the 'explosion' showers associated with cosmic rays. One may, in fact, estimate, on the basis of these ideas, the relative probabilities for the emission of light nuclei from a highly excited heavy nucleus, like those recently observed in the multiple disintegration processes produced by cosmic rays[2]. Further, an elementary calculation allows us to estimate the number of mesons and electrons (positive and negative) in an excited nucleus. In the following table, r denotes the ratio of the meson concentration to the electron concentration (this quantity may be taken as comparable with the ratio of the numbers of mesons and electrons emitted in explosion showers); E denotes the (average) energy per particle (electron or meson); and n the total number of electrons present in a heavy nucleus (mass number, 200).

E (MV.)	n	r
5·0	13×10^{-3}	41×10^{-9}
15	55×10^{-2}	67×10^{-4}
35	70×10^{-1}	85×10^{-3}
69	54	13×10^{-2}
∞	∞	1

A detailed paper will be published elsewhere.

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March 22.

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[1] Chandrasekhar, S., and Henrich, L. R., *Astrophys. J.*, **95**, 288 (1942). Singwi, K. S., and Rai, R. N., *Proc. Nat. Inst. Sci. India*, **12**, 291 (1946).

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A Short Method for Calculating Maximum Battery Reliability

THE method devised by Thomson[1] for obtaining test weights which give maximum battery reliability can be simplified to lead to much shorter computation.

The correlation between a set of tests, the a variates, and their second application, the α variates, can be symbolized by the matrix $\begin{bmatrix} R_{aa}R_{aa} \\ R_{aa}R_{aa} \end{bmatrix}$, where, under the conditions set out by Thomson, $R_{aa} = R_{aa}$ and $R_{aa} = R_{aa}$. Treating battery reliability as a special case of Hotelling's battery prediction[2], Thomson finds its maximum value by maximizing $u'R_{aa}R_{aa}^{-1}R_{aa}u$ under the condition $u'R_{aa}u = 1$, where u is the vector of test weights which make battery reliability a maximum. Thomson, therefore, requires to solve the equation

$$|R_{aa}R_{aa}^{-1}R_{aa} - \lambda R_{aa}| = 0 \quad . \quad . \quad (1)$$

for its largest root λ_1. This root is equal to r_m^2, where r_m is the maximum battery reliability and the weights u are in the ratio of the elements of any row of the matrix $\mathrm{adj}(R_{aa}R_{aa}^{-1}R_{aa} - \lambda_1 R_{aa})$.

In the method I now suggest the weights u are the same for both applications of the test battery (ref. 1, p. 359) and battery reliability is given by

$$r = \frac{u'R_{aa}u}{u'R_{aa}u}, \quad . \quad . \quad . \quad . \quad (2)$$

and *maximum* reliability follows by maximizing $u'R_{aa}u$ under the condition $u'R_{aa}u = 1$. We thus require to solve the equation

$$|R_{aa} - \lambda R_{aa}| = 0 \quad . \quad . \quad . \quad (3)$$

for its largest root λ_1, which in this case is equal to the maximum reliability r_m. The weights u are given by any row of the matrix $\mathrm{adj}(R_{aa} - \lambda_1 R_{aa})$.

Use of equation (3) avoids the awkward triple product $R_{aa}R_{aa}^{-1}R_{aa}$ in equation (1) and so shortens the computation considerably. The method I have outlined can be proved to lead to the same results for r_m and u as Thomson's method.

E. A. PEEL

The University,
Durham.
April 2.

[1] Thomson, G. H., *Brit. J. Psychol.*, **30**, 357 (1940).

[2] Hotelling, H., *J. Educ. Psychol.*, **26**, 139 (1935).

Densest Packing of Equal Spheres

THE two equally dense cubic and hexagonal packings discovered by Barlow[1] in 1883 are now widely known. But it does not appear to be equally well known that there are also four homogeneous mixtures of these; so that we have in all no less than six homogeneous arrangements all possessing maximum density. Barlow himself was aware of the possibility of admixture[2], but so far as I know the matter has never been fully expounded, and in view of the increasing practical importance of the subject it is perhaps well that it should be.

When equal plastic spheres are arranged cubically and then uniformly compressed, they become rhombic dodecahedra. Spheres arranged hexagonally become in like circumstances trapezo-rhombic dodecahedra.

Take, therefore, quantities of rhombic dodecahedra (R) and trapezorhombic dodecahedra (T) to represent the *Wirkungsbereich* of sphere-centres in a homogeneous structure. We note that there cannot be more than two successive layers ($2R$) or ($2T$) in a homogeneous mixture; for when there are three, the polyhedra in the middle layer are completely surrounded, and therefore *all* polyhedra in additional layers must be surrounded in the same way. In other words, if three successive layers are all R (or T), then all layers in the structure must be R (or T), and the arrangement is Barlow's cubic (or hexagonal).

It remains only to determine the possible arrangements of polyhedra in which not more than two successive layers are of the same kind, and it is found upon trial that there are four, and no more.

Starting with all layers R, substitute a single T layer; we then have:

Homogeneous mixture No. 1. $T,R,R,T,R,R,\ldots$
" " No. 2. $R,T,R,T,R,T,\ldots$

Substituting two successive T layers, we have:

Homogeneous mixture No. 3. $R,R,T,T,R,R,T,T,\ldots$
" " No. 4. $R,T,T,R,T,T,R,T,T,\ldots$

where successive letters in a row indicate the nature of successive vertical layers in the structure.

In No. 1 the seventh layer overlies and has the same orientation as the first; in No. 2 the fifth; in No. 3 the thirteenth; and in No. 4 the tenth.

SIDNEY MELMORE

61 Carr Lane,
Acomb, York.
April 3.

[1] Barlow, W., *Nature*, **29**, 186 (1883).

[2] Barlow, W., and Pope, W. J., *J. Chem. Soc.*, **91**, 1158 (1907).

Richmondite, a Discredited Mineral Species

EIGHTY years ago William Skey[1,2] analysed and described a mineral from Richmond Hill in northwest Nelson, New Zealand, naming it 'richmondite'. His analysis of this material, after deducting 15·4 per cent for siliceous gangue and antimony oxychloride, is as follows: PbS 36·12, Sb_2S_3 22·20, Cu_2S 19·31, FeS 13·59, ZnS 5·87, Ag_2S 2·39, MnS 0·52, Bi_2S_3 traces: total 100. From this analysis Skey calculated the formula $Sb_2S_3.6RS$ (where R = Pb, Cu, Fe, Ag, Zn), and it was his belief that the mineral, though quite distinct from tetrahedrite, was related thereto.

I have prepared polished surfaces from a number of specimens labelled 'Richmondite' that exhibit the properties described by Skey, and I find that not one of these specimens is homogeneous. Instead, the following minerals were found in each specimen: argentian tetrahedrite, galena, sphalerite, chalcopyrite, pyrite, and possibly stromeyerite; these minerals are placed in order of abundance, although in some instances sphalerite is more plentiful than galena. The galena shows no traces of inclusions of argentite, and chemical tests on powder obtained by scratching the surface of the grains did not suggest the presence of any silver in the galena. The tetrahedrite, on the other hand, contains much silver, but unfortunately the powder was not sufficiently pure to warrant a quantitative determination.

Within the tetrahedrite, however, are to be seen occasional, very small inclusions of grey colour that are distinctly anisotropic. The mineral is soft, has a blackish streak, and the standard etch tests give the following reactions: nitric acid, stains iridescent; hydrochloric acid, negative; potassium cyanide, quickly stains black; ferric chloride, stains iridescent; potassium hydroxide, negative; mercuric chloride, stains slowly. These characters are closely comparable to, and suggest, stromeyerite[3].

Therefore, in view of the lack of homogeneity in the material known as 'richmondite', the latter cannot be considered a true mineral species, and the name should be abandoned.

C. OSBORNE HUTTON

Department of Geology,
University of Otago,
Dunedin, New Zealand.
Feb. 27.

[1] Skey, W., *Trans. N.Z. Inst.*, **9**, 556 (1877).

[2] Skey, W., 12th Ann. Rept., Col. Mus. and Lab., Wellington (1878).

[3] Short, M. N., U.S. Geol. Sur. Bull. 914 (1940).

Relative Directions of the Electric and Magnetic Vectors in Electromagnetic Waves *in vacuo*

IN my recent communication in *Nature*[1] on the relative directions of the electric and magnetic vectors in electromagnetic waves *in vacuo*, the words "Even if the electric and the magnetic vector were orthogonal to its respective curl (which is *not always* the case), it would only follow from the Maxwell equations" should be substituted for "It follows from the Maxwell equations". The original version implied that in the electromagnetic waves *in vacuo* the electric and the magnetic vector is *always* perpendicular to its respective curl, which is not true, and, apart from this, was superfluous in the main argument.

This correction is the sequel of letters which I have received from Prof. Erwin Schrödinger and from Dr. K. M. Guggenheimer, who wrote to me quite independently about ten days later. To both of them I wish to acknowledge my indebtedness.

N. S. JAPOLSKY

Royal Institution,
21 Albemarle Street,
London, W.1.

[1] *Nature*, **159**, 580 (1947).

LEAD SULPHIDE PHOTOCONDUCTIVE CELLS

By L. SOSNOWSKI, J. STARKIEWICZ
AND
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Admiralty Research Laboratory, Teddington, Middlesex

Manufacture

IN view of the interest being shown in the applications of lead sulphide cells[1,2] and in the photoelectric properties of the sensitive material[3], it is desirable to give a brief account of the method of manufacture of these cells, and to specify the conditions which govern the appearance of high photosensitivity. The method of manufacture described here has been developed during the last two years at the Admiralty Research Laboratory.

There are three main processes involved:

(i) About 4 mgm. of lead sulphide, enclosed in the 'Pyrex' cell blank, is heated in oxygen (pressure about 0·2 mm. mercury) at 550°–600° C. The sulphur dioxide evolved is removed. This process results in the conversion of some of the lead sulphide into lead oxide (PbO); the amount of oxide is not critical (5–40 per cent).

(ii) This material is used to form a layer 1–2 microns in thickness by evaporation on to a glass surface bearing graphite electrodes. The evaporation is made in oxygen (pressure about 0·2 mm. mercury).

(iii) The layer is then heated in oxygen (pressure as before) up to 450° C. This treatment is the most critical and is controlled by observing the variations in conductivity of the layer. The conductivity, which initially increases with the temperature, afterwards decreases and goes through a minimum; it is necessary to continue the heating until this minimum has been passed and a rapid increase of conductivity occurs (at about 400° C.). The cell is then cooled rapidly to room temperature in oxygen and evacuated. In some cases the sensitivity may be improved by a short heating *in vacuo* to 250° C.

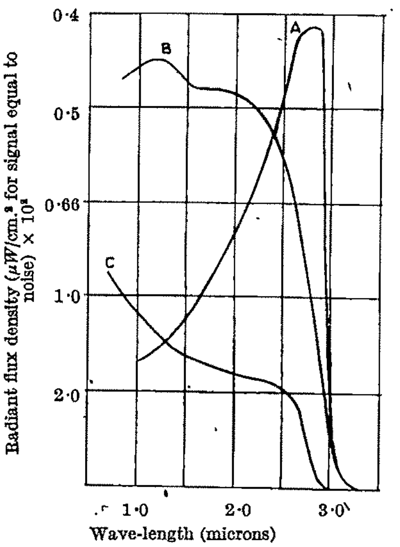

Fig. 1. SPECTRAL SENSITIVITY OF TYPICAL LEAD SULPHIDE CELLS. RADIATION INTERRUPTION, 800 C./SEC.; 30-CYCLE BAND-WIDTH

Cells prepared in this way have retained sensitivity to date. They have a response time of the order of 0·1 millisec. and exhibit linear response to weak illumination. Curve *A*, Fig. 1, shows the spectral response of a typical cell. If the concentration of lead oxide is high, the spectral response is altered, and a secondary peak appears at about 1 micron. The relative intensity of this peak increases with the amount of lead oxide, the maximum sensitivity being shifted into the visible region. Curves *B* and *C* show the response of two cells with progressively increased proportions of lead oxide.

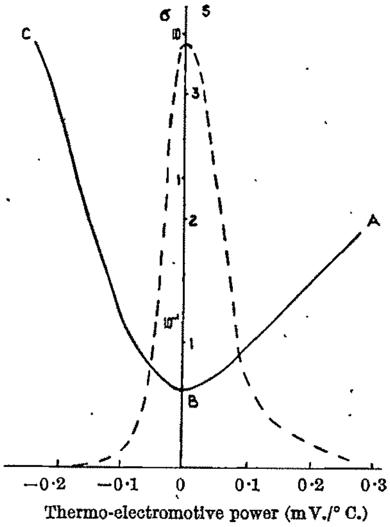

Fig. 2. VARIATION OF CONDUCTIVITY (FULL LINE) AND SENSITIVITY (BROKEN LINE) WITH THERMO-ELECTRIC POWER

Our measurements of Hall coefficient and thermoelectric power have established that layers may be predominantly excess conductors or defect conductors, associated respectively with excess of lead or oxygen impurity centres. Fig. 2 shows the relationship between the thermal E.M.F., the conductivity, and the photosensitivity of a sensitized layer which was initially a defect conductor (point *A*). The graph was obtained by applying successive heatings to 250° C. *in vacuo*. It was independently proved that this treatment effects the removal of excess oxygen but does not create any lead impurities. Since the thermal E.M.F. changes sign from positive to negative (point *B*) while the conductivity rises rapidly (from *B* to *C*), it is necessary to assume that there are lead centres in the layer which must have been present even when excess of oxygen produced a resultant defect conductivity. This lead is formed in dynamic equilibrium with lead sulphide and various oxidation products during oxidation at temperatures above 400° C. Thus stage (iii) in the preparation causes changes in the concentrations of both lead and oxygen impurity centres. The variations in conductivity which occur during this treatment may be fully explained in terms of these changes.

The maximum sensitivity is assured when both kinds of impurity centres are present in sufficient quantity, and with relative concentration such that the minimum conductivity and zero thermoelectric power are obtained. No sensitivity has ever been obtained with only one type of impurity centre present.

Theory of the Photoeffects

We have already discussed[4] briefly our experimental work on the photoconductive and photovoltaic effects in lead sulphide.

The critical experimental results that must be taken into account are: (i) that sensitive layers can be produced with rectifying and photovoltaic properties; and (ii) that photoconductivity is necessarily associated with the simultaneous presence of lead and oxygen impurity centres.

It seems unlikely that photosensitivity could be associated with uniform distribution of impurity centres of two kinds. We therefore postulate the existence of regions in which there is an excess of lead, and regions where oxygen impurity centres are predominant. It is natural to attribute these inhomogeneities to differences in size and chemical composition (lead oxide content) of the individual microcrystals comprising the layer. Purely random variations might be a contributory factor.

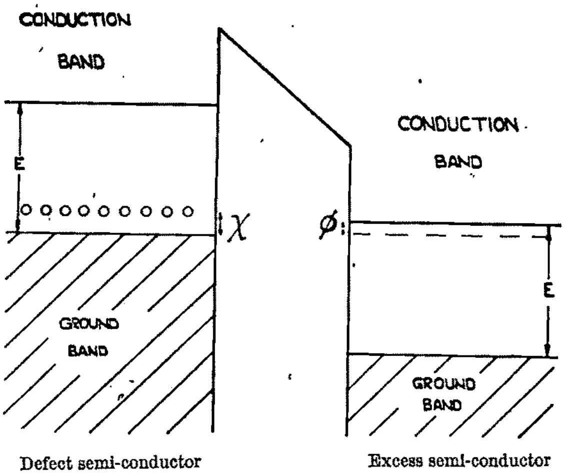

Fig. 3. ENERGY-LEVEL MODEL

○ ○ ○, oxygen impurity centres.
- - - -, lead „ „

We now discuss the boundary between two regions, one containing excess of oxygen and the other excess of lead. In equilibrium, the density of electrons in any energy state must be identical on either side of the boundary. There will be, therefore, a flow of electrons across the boundary from the side of excess lead, resulting in the formation of a space charge. A simplified model of the energy-level scheme in equilibrium is shown in Fig. 3. The relative displacement of the levels will be dependent on temperature, but the dependence can be neglected in the case considered (number of impurity centres much greater than the number of intrinsic electrons at room temperature). Our observations on the behaviour of lead sulphide containing one kind of impurity only indicate that φ and χ are small compared with kT. A concentration of impurity centres of about 10^{19} per c.c. on either side of the boundary may represent the typical case. The displacement E between ground-level and conduction bands is approximately 0·5 eV. as deduced from the long-wave limit of the main absorption spectrum of lead sulphide.

Any boundary of the type shown in Fig. 3 will have rectifying properties. The electron flow can be due to the passage of electrons between the conduction bands, between ground-band and conduction-band, and between ground-bands, the relative contribution depending on applied voltage and barrier characteristics. For low values of applied voltage the first process predominates, giving a direction of easy flow from right to left. As the concentration of electrons in the conduction band on the left is very small (about 10^{11} per c.c.), the resistance of the barrier is high compared with the resistance of the semi-conducting material.

If the absorption of infra-red radiation ejects electrons from the ground-band or oxygen impurity centres into the conduction band, the concentration of electrons which are able to cross the barrier will be greatly increased, with corresponding reduction of resistance. Even when there is no applied potential, photo-electrons will still diffuse across the barrier. The probability of return is negligible, since once the electrons have diffused across to the right of the barrier, the loss of energy due to collision will prevent return. In consequence a photo-electromotive force will be generated.

We believe that this mechanism is responsible for the photovoltaic effect in lead sulphide (*loc. cit.*). More direct evidence has since been obtained by preparing a layer one half of which contained excess lead and the other excess oxygen, as was verified by measurements of thermal E.M.F. This layer contained effectively only one barrier of the type described, and showed the photovoltaic effect with the direction predicted by the theory.

If a layer contains many barriers distributed at random, the photovoltaic and rectifying effects will not be observable. However, the existence of the barriers will be the main factor controlling the resultant conductivity of the whole layer. Illumination will ease the flow of electrons, which accounts for the photoconductivity.

Between the barriers the current may be carried either by electrons or by positive holes, depending upon the type of impurity predominant in the region. Across the barriers the main contribution to the current is due to electrons, and there is some evidence that the Hall coefficient becomes negative (or less positive) on illumination.

According to this model, the spectral characteristics should be similar for the photoconductive and photovoltaic effects; furthermore, it should be determined mainly by the energy difference E between the top of the ground-level and the bottom of the upper conduction band, the actual position of the impurity-levels being of secondary importance. The first of these points has been verified experimentally, and support is given to the second by the appearance of a short wave-length peak when the concentration of lead oxide is high.

The above discussion has dealt only with the main aspects. A quantitative treatment based on the above model has given results in general agreement with experiment for features such as sensitivity, rectifying effect and time of response.

We have to acknowledge the assistance of Messrs. J. Beattie and D. Phillips in supplying the data on sensitivity and spectral response.

A complete report on the preparation and properties of lead sulphide cells and on the theory of the photoelectric effects is in the course of preparation.

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[1] Lee, E., and Parker, R. C., *Nature*, 158, 518 (1946).

[2] Sutherland, G. B. B. M., Blackwell, D. E., and Fellgett, P. B., *Nature*, 158, 873 (1946).

[3] Hepner, W. A., *Nature*, 159, 96 (1947).

[4] Starkiewicz, J., Sosnowski, L., and Simpson, O., *Nature*, 158, 28 (1946).

PLOT-SIZE IN YIELD SURVEYS

By Dr. V. G. PANSE
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RECENT communications by Sukhatme[1,2] and Mahalanobis[3] have established the conclusion that sample plots of a small size (25 sq. ft. or less according to Mahalanobis) give biased estimates of yield in sample surveys ; but whereas Sukhatme has shown the bias to persist even with a plot-size of 118 sq. ft., Mahalanobis has expressed the view that it becomes practically negligible for plots of size larger than 40–50 sq. ft. Their results relate to crops grown unevenly by broadcasting the seed or sowing it in irregular lines. I have studied the problem of plot-size in yield surveys on cotton, which is sown by a drill in evenly spaced rows in Central India. The results[4] are summarized here, as they provide for the first time information on this question applicable to drill-sown crops.

Plots of three sizes, 1/20, 1/200 and 1/2,000 acre, were compared. In crops sown in uniformly spaced rows, plot-size is defined by a specified length of a given number of contiguous rows. The plots in the present experiment were marked according to this definition, and since the actual plot-sizes differed slightly from the standard size owing to small variations in row spacing, the plot-yields were reduced to the standard size before analysis. Two plots of each size or six plots in all were laid down at random locations in the field. The experiment was done in twenty-six fields at Indore and in an equal number of fields at Government farms in the Central Provinces. In addition to the yields of the plots, yields of whole fields were accurately measured at the Government farms ; but this was unfortunately not possible at Indore. Average yields of seed cotton per acre estimated from the three plot-sizes were :

	Yield (lb. per acre)	
Plot size	Indore	Central Provinces
120 acre	195·7	322·2
1/200 „	197·0	354·9
1/2,000 „	221·3	421·8

There was a gradual increase in yield per acre as the plot-size was decreased in the Central Provinces experiment. At Indore also the yield from the smallest plot was larger than the other two. A comparison between different plot-sizes did not, however, reveal significant differences in yield, though the excess of yield estimated from 1/2,000-acre plots over 1/20-acre plots in the Central Provinces was almost twice its standard error. The comparison of yields estimated from sample plots with the yield obtained by harvesting the whole fields in the Central Provinces proved more conclusive, as shown below :

Comparison of plots with whole fields	Difference in yield (lb. per acre)
1/20 acre plot	26·7 ± 26·5
1/200 „ „	59·4 ± 28·1
1/2,000 „ „	126·3 ± 57·6

The yield estimated from 1/20-acre plots agreed quite well with the yield for the whole field, as the difference between the two was no more than its standard error ; but the excess of the yield estimated from the other two plots over the yield from the whole field was greater than twice its standard error and clearly significant. With 1/2,000-acre plots, the over-estimation was as high as 42·7 per cent of true yield.

Thus, not only did the smallest plot size, 1/2,000-acre or 22 sq. ft., give highly biased results, but also there was an indication of bias also with the plot size of 1/200 acre or 218 sq. ft. in the Central Provinces experiment. The latter result would seem to show that even plots of 200 sq. ft. cannot always be relied upon to give unbiased estimates of yield. The second conclusion from this experiment is that although small plots, such as those used by English and American workers for sampling drill-sown crops, may not be open to serious objection for comparative purposes, the possibility that yield estimates derived from such plots are seriously biased needs attention.

[1] Sukhatme, P. V., *Nature*, 157, 630 (1946).

[2] Sukhatme, P. V., *Nature*, 158 345 (1946).

[3] Mahalanobis, P. C., *Nature*, 158, 798 (1946).

[4] Panse, V. G., *Curr. Sci.*, 15, 218 (1946).

FUTURE OF PAINT*

MODERN developments in plastic materials have forced the paint industry to concern itself with an ever-increasing number of film-forming substances—synthetic rubbers, resins and oils ; and researches on pigments have not lagged behind. The electron microscope reveals the shape of particles too small for optical resolution. Pigment particles had been assumed to be spherical ; it transpires, however, that of the pigments commonly used only carbon particles have this shape. The shape of carbon particles is independent of the material from which the pigment is prepared. Carbon smoke is different from other inorganic smokes, which, with the exception of aluminium oxide, yield crystalline particles, and the reason for this difference has not been fully explained. The carbon pigments have another interesting property, namely, that of forming chains, like beads on a string. Such an arrangement may be due to electrostatic charges ; but whatever the cause, the condition probably accounts for the high electrical conductivity of carbon-pigmented paint.

Study of the forces which exist at the interface between pigment and medium has shown that they develop the plasticity of the paint on which its working properties depend, and later determine the manner of film formation and structure. Usually they develop quickly and promote dispersion of the pigment. There are cases, however, which can be regarded as dramatic exceptions ; for example, sparks up to half an inch long accompany the attempted dispersion of titanium dioxide by grinding in tricresyl phosphate under electrically insulated conditions, whereas in the presence of a trace of surface-active material (oleic acid) dispersion proceeds normally without the visible release of energy. When paint fails, that is, cracks and exfoliates, the shrinkage forces overcome the combined forces of cohesion (pigment/medium) and adhesion (film/support). When adhesion is good, the development of other paint defects is delayed.

Research into these matters has been conducted by the optical examination of paint sections. In order to use the electron microscope for examination of paint films it is necessary to prepare a replica of the paint surface on a material sufficiently thin to transmit the electron beam. This is done by taking a negative impression of the surface structure of the paint by the simple process of spreading methyl

* Substance of the Friday Evening Discourse entitled "Whither Paint ?" delivered by Dr. L. A. Jordan at the Royal Institution on March 7.

cellulose solution upon it. When dry, this is stripped off and a positive impression is prepared by allowing evaporated silica to condense on the surface in a vacuum; after removal of the methyl cellulose, the siliceous replica is ready for examination. By this technique it is possible to observe the disruption of a paint surface in its early stages—even after a few hours of exposure to accelerated ageing and weathering in the laboratory.

Red lead is generally still the first choice as a rust-inhibitive pigment in spite of many interesting developments in the study of corrosion of iron. Its disadvantages are its density and scarcity. Lead cyanamide is of lighter colour and somewhat lower density, and is being developed as a substitute for red lead.

During the War many special-purpose paints were used; for example, luminous paints, conducting paints and paints sensitive to changes of humidity and temperature. The active agent in almost every case was the pigment, which itself acted as the indicator of the changes, usually by a variation of colour. An interesting feature of luminous materials is that the energy stored as a consequence of activation is quickly released when the paint is heated. This energy can also be released by increasing the internal friction. Thus, when a luminous paint film is bent inwards there is a release of energy as a flash of light. When the bend is outward (internal friction not so great) the energy released is much smaller. The bending of a paint film also modifies its electrical conductivity. This effect is more readily observed with a carbon pigment, the electrical conductivity of which is presumed to be due to the chains of carbon particles which it contains. Bending inwards (compression) decreases the electrical resistance by bringing the carbon particles nearer together: bending outwards has the opposite effect. Graphite is lamellar in form, and its low resistance is ascribed to chains of overlapping plates lying within the paint film. But not all lamellar pigments form a conducting path, even if composed of a material of low resistance. The outstanding example is aluminium paint, which gives a bright metallic film but which, however, is non-conducting. The plates are insulated from each other by a surface film of polishing agent, usually a stearate, and a tightly held oxide layer. The polishing agent is responsible for the floating and leafing of the particles within the paint film, whence arises its lustre. A conducting paint film can be obtained from copper powder only when the surfaces are chemically clean and are maintained in the reduced condition.

The use of paint as a medium for employing chemical compounds that undergo colour changes at certain critical temperatures has met with a certain amount of success, and organic dyestuffs giving a colour change that is irreversible with temperature can be used to record temperatures inside machinery where the use of thermometers or thermo-couples would be impracticable. A particular example of this application is in recording whether or not a bearing has been overheating. Compounds with reversible colour changes have also been of use, and the double iodide of copper and mercury, which changes from red to black as the temperature rises above 90° C. and gives the reverse colour change on cooling, served, during the War, as an indicator on the distillation apparatus of lifeboats. It was easier for men in distress to note a change of colour than to have to read a thermometer.

In recent years most old-established industries have attempted to introduce scientific tests that would be independent of the human element, and the paint industry is no exception. A difficulty arises, however, in the recording of such qualities of a painted surface as 'gloss' and 'lustre', which are normally judged by the human eye. Experience of instruments devised for such measurement has shown that these properties are not measurable in the same way as mass and length, but that they have a subjective element which, so far, has defied instrumental interpretation. This brings us to the fundamental characteristic, the measurement of colour, which provides its own psychological problem. Accurate tricolorimetric or spectrophotometric measurement permits recording of primary colour and brightness values which are now accepted as the ultimate standards against which the colour patterns or secondary standards may be checked at intervals. The difficulty arises in deciding what can be taken as an acceptable match to a standard colour with permissible tolerances. The methods of colorimetry have reached a high degree of precision, but they only deal with colour objectively; they measure stimuli and not the sensation of colour. What is wanted is a relationship between stimulus and the corresponding changes in mental colour-sensation, and if such a relationship could be established it would no doubt contribute to the solution of one of the outstanding problems of the paint industry, namely, control of the drift of patterns away from their original colour, even when they are kept in the dark.

As to the future, it is certain that new products will produce new and improved paints. The corrosion problem may be expected to diminish with the use of less corrodible materials; but whatever happens in this respect there will always be the desire to provide good appearance and pleasing colours.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, June 16

UNIVERSITY COLLEGE, LONDON (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Kapp: "The Presentation of Technical Information", Second Series, 3: "The Part Played by Logic in Presentation".*

Tuesday, June 17

RESEARCH DEFENCE SOCIETY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 3.15 p.m.—Annual General Meeting. Prof. G. H. Wooldridge: "What Animals Owe to Experimental Research" (Sixteenth Stephen Paget Memorial Lecture).

MEDICAL RESEARCH COUNCIL (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Dr. J. G. Hamilton (Radiation Laboratory, Berkeley, Calif.): "Applications of Radio-active Isotopes in Medicine".*

Wednesday, June 18

GEOLOGICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. C. E. N. Bromehead: "A Geological Museum of the Early Seventeenth Century".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Sir Gilbert T. Walker, F.R.S.: "Arctic Conditions and World Weather"; Mr. S. Duvdevani: "An Optical Method of Dew Estimation".

Thursday, June 19

CHADWICK PUBLIC LECTURE (at the Chelsea Physic Garden, Swan Walk, London, S.W.3), at 4 p.m.—Prof. W. H. Pearsall, F.R.S.: "Water Supply and Freshwater Biology".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. M. Cwilong: "Sublimation in a Wilson Chamber"; Sir Lawrence Bragg, F.R.S., and Mr. J. F. Nye: "A Dynamical Model of a Crystal Structure".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. G. A. Schnellmann and Mr. J. D. Willson: "Lead-Zinc Mineralization in North Derbyshire"; Mr. E. W. O. Dawson: "War-time Treatment of the Lead-Zinc Dumps situated at Nenthead, Cumberland".

London Mathematical Society (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. H. C. Whitehead, F.R.S.: "Maps of 3-Dimensional Spheres on 2-Dimensional Spheres".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 8 p.m.—Annual General Meeting; Brigadier Sydney Smith: "Prisoner of War Camps in the Middle East".

Friday, June 20

Institute of Physics, Industrial Spectroscopic Group (joint meeting with the Scottish Branch of the Institute of Physics, and the Spectrographic Discussion Group, Glasgow, in the University, Glasgow), at 9.30 a.m.—Dr. R. L. Mitchell and Dr. R. O. Scott: "The Spectrographic Analysis of Non-Conducting Powders in the Carbon Arc"; at 2 p.m.—Dr. E. W. H. Selwyn: "The Photographic Aspect of Spectroscopy"; at 3.30 p.m.—Mr. G. P. Mitchell and Mr. P. Popper: "The Use of the Multiplier in Emission Spectroscopy".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Mathematics, and a Lecturer in Chemistry—The Principal, Central Technical College, Suffolk Street, Birmingham 1 (June 21).

Lecturer in Mathematics—The Registrar, Technical College, Sunderland (June 21).

Senior Assistant in Mechanical Engineering, a Senior Assistant in Metallurgy, a Responsible Lecturer in Structural Engineering, a Lecturer in General Chemistry, and a Lecturer in Mechanical Engineering, at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (June 21).

Lecturer in Physics—The Clerk to the Governors, Royal Technical College, Peel Park, Salford 5 (June 21).

Lecturer in Mining and Engineering Subjects—The Principal, Technical Institute, Clowne, Chesterfield (June 21).

Lecturer in Applied Mathematics at the Ipswich School of Technology—The Chief Education Officer, 17 Tower Street, Ipswich (June 21).

Lecturer in the Department of Electrical Engineering, and a Lecturer in Biology and Horticulture, at the City Technical College, Liverpool—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (June 21).

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Soil Technologist by the Government of Iraq—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14628.

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Lecturer in Mathematics, and a Lecturer in Zoology—The Principal, Guildford County Technical College, Stoke Park, Guildford, Surrey.

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CONTROL OF ATOMIC ENERGY

ALTHOUGH freely quoted, the first report of the Atomic Energy Commission to the Security Council of the United Nations, dated December 31, 1946 (see *Nature*, May 3, p. 616), does not yet appear to have been generally available in Great Britain. It is the more important, therefore, that the situation should be repeatedly and publicly discussed, and that the facts and their implications should be made known alike by such means as *Current Affairs*, the December 28, 1946, issue of which was devoted almost entirely to a review by Peter Wright entitled "The Future and the Atom Bomb", and by the series of broadcast talks arranged by the British Broadcasting Corporation in the spring and published in *The Listener* of March 13. Such popular expositions are important adjuvants to the efforts of the Atomic Scientists Association and the survey of the Committee on Science and its Social Relations of the International Council of Scientific Unions, especially when, as in *Current Affairs*, they are documented for further reading.

For that reason the debate in the House of Lords on April 30 on a motion by the Archbishop of York deserves more than passing notice; it was also notable as the first occasion for an authoritative public discussion in the Houses of Parliament on the present political deadlock regarding the atomic bomb. The statement made on June 11 on behalf of the Soviet Government by Mr. Gromyko, although it suggests movement towards the views of the remainder of the Atomic Energy Commission, is still not clear on the subject of the proposed international authority and its autonomy.

The main theme of the Archbishop of York's speech was the urgency of the situation; but there was a striking similarity in the trend of his thought to that in the latest report of the President of the Carnegie Institution of Washington. Commenting on the bearing on the Institution's work of this scientific revolution in warfare which has given the application of science a central place in national security, Dr. Vannevar Bush recognizes that there is an important time factor, and that the principal question is whether there must be another demonstration of the power of applied science to destroy before mankind realizes that a new approach towards international functioning is demanded; but he also urges that the race between the power of weapons and the power of understanding is not altogether one-sided. Dr. Bush points out that the application of science has done more than create a destructive power which has made a world organisation essential: it has also provided the means of swift communication and transport which make real unity possible, and progress in medicine has done much to make possible that healthy outlook on life which is necessary for great movements of collaboration. The Archbishop of York, while not regarding as necessarily fatal the Russian insistence on a prior convention outlawing the use of the atomic bomb, provided that agreement could be reached as to the destruction of bombs not handed over to the authority as soon as that authority is effectively established, believes that the limitation on inspection is a most serious difficulty, and that the dangers are very real unless an international authority is speedily brought into existence. Nor can there be any effective authority, in his opinion, unless it is able to override national sovereignty at least to some extent. The first and most practical step towards the abolition of war is the creation of an authority with real power of control and inspection.

Here Dr. Garbett took up a position which men of science have consistently occupied from the start, and he went on to urge in words reminiscent of General Smuts' presidential address to the British Association at its centenary meeting, that the position has arisen because man's immense advances in scientific knowledge have not been accompanied by corresponding advances in moral stature. Lord Cherwell, who followed, at once agreed with what Dr. Garbett said both on this point and especially on the necessity of the nations agreeing to transfer some part of their sovereign independence to an authority able to administer the law and enforce order; his main disagreement with the Archbishop being on the latter's comments on the Bikini experiments. Lord Cherwell made it clear that he rests his own hopes chiefly on proceeding along the lines outlined in the American plan, which he considers is realistic, detailed and carefully thought out. While nations cling to the inviolability of national sovereignty, there is, he believes, little hope of achieving any useful result in the negotiations. Without some authority to enforce the law, and standing above all the members of the community, the best laws in the world are of little avail.

It cannot be said that in this debate there was any clear indication as to how the deadlock created by the Russian attitude can be resolved. Earl Russell insisted that the fundamental question is not of Russian interests, American interests or British interests; but of human interests. Ultimately, it is a question of the abolition of war, and if it is possible that the attempt to isolate and to deal separately with the atomic problem is a mistake, it may none the less be valuable if we can demonstrate, even in a limited field among the nations willing to participate, the practicability of an international authority such as the Lilienthal Report has outlined. That was Lord Lindsay's contention; and Viscount Addison, reviewing the position for the Government, could say but little more than that the technical committee has reported unanimously to the Atomic Energy Commission that it is possible to extend among all nations the exchange of basic scientific information on atomic energy for peaceful ends; to control atomic energy to the extent necessary to ensure its use only for peaceful purposes; to ensure the elimination from national armaments of atomic weapons; to provide safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions.

These, as Viscount Addison said, are four vital conclusions, but they represent only a small step forward; and although the Atomic Energy Commission has now been asked by the Security Council to resume its work, it would seem that the main hope of progress lies in the formation of a public opinion—in Great Britain and in other countries—which fully understands what is involved and is determined that the price of peace shall be paid, no matter what sacrifice of national sovereignty is required. What needs to be grasped as firmly and widely as possible is that technical opinion is agreed as to the feasibility of control, and that such control means some surrender of national sovereignty. It is the task, then, of those who have understood this issue to bring home to their fellow citizens that this is now a matter of human rights, and of one of those four human freedoms with which President Roosevelt touched the imagination of the freedom-loving peoples. Here, as in the matter of an international police force, it must be made clear to all where the threat to human rights arises, and exactly where progress is being obstructed. Nothing has yet emerged from the debates of the last eighteen months which suggests that any wide deviation is likely from the principles outlined in the Baruch plan. While men of science, through the Atomic Scientists' Association and in other ways, continue to address themselves to this task of educating world opinion, they should equally continue the detailed discussion of the plan on which so much time has already been spent; they should seek to formulate an international document in which the exact nature and mode of operation of an international authority are clearly stated, and work to secure its demonstration in practice in as wide a field as is possible.

ADVANCES IN BIOCHEMISTRY

Advances in Enzymology and Related Subjects of Biochemistry

Edited by F. F. Nord. Vol. 6. Pp. x+563. (New York: Interscience Publishers, Inc., 1946.) 6.50 dollars.

THE articles contained in "Advances in Enzymology", like those in the "Annual Reviews of Biochemistry", are becoming increasingly indispensable to research workers, teachers, and writers of text-books on biochemistry. Reviews of the progress made in the various branches of this rapidly expanding science have become essential to all who wish to keep abreast of the literature. The writers of these reviews have great responsibilities, for their readers look to them not only for an authoritative exposition of recent advances but also for an unbiased judgment on the new developments and for full acknowledgment of the work of all research workers who have contributed to the advances. This duty of fair presentation and appraisal is usually faithfully carried out. This seems clearly to be the case, so far as the writer is able to judge, with the articles in the volume of "Advances in Enzymology" under review.

Dr. E. F. Gale writes a very useful and timely article on the subject of bacterial amino-acid decarboxylases, a subject to which he himself has made very important contributions. These enzymes are responsible for the breakdown, in bacteria, of amino-acids to amines, and Gale has shown that they are formed within bacterial cells in response to certain well-defined conditions of growth. The enzymes have been obtained and studied in cell-free condition. Dr. Gale's article describes in detail the conditions necessary for the formation of the amino-acid decarboxylases, the manner in which enzyme production is affected by the amino-acid in presence of which the bacteria are grown and the importance for the process of decarboxylation of a coenzyme, which the work of Bellamy and Gunsalus, and of Snell, has shown to be pyridoxal phosphate.

Reviews of the biochemistry of amylases are written by R. H. Hopkins and by W. F. Geddes. It is now more than a hundred years since Payen and Persoz (in 1833) applied the name diastase to the starch-splitting enzymes of barley malt; this name persisted until recent times, but the term amylase is now preferred. Although there is no general agreement, according to Geddes, on the number of enzymes which are involved in starch hydrolytic breakdown, two main types are required, namely, β-amylase, the so-called saccharogenic amylase, and α-amylase, the dextrinogenic and liquefying amylase. Hopkins' article deals with the general features of α- and β-amylases, describes the influence of ions on these enzymes and discusses their stabilities and kinetics. He considers that α-amylase "is the fundamental amylase with its high affinity for starch and its power of relatively rapid dextrinization" and that β-amylase "fulfils the role of an accessory which speeds up and completes the process of saccharification". Geddes' extensive article not only describes the occurrence and properties of the amylases and other starch-splitting enzymes, but also gives a very useful survey of the biochemistry of bread-making and of the part played by amylases in this process. The article describes the amylases of sound and germinated wheats, the factors affecting the maltose value of wheat flour, and the relation between autolytic maltose production and flour gassing power. The article is an important one, not only for its information on amylases but also for an appreciation of the significance of these enzymes in milling and baking technology.

Another enzyme, adenosine triphosphatase, is the subject of an article by Engelhardt. This article deals with the enzymic properties of myosin, the muscle protein, which is capable of bringing about the hydrolysis of adenosine triphosphate. This molecule "is the last link in the long chain of reactions which make available for the performance of mechanical work the chemical energy enclosed in the carbohydrate molecule. The principal agent that performs this work is the protein, myosin, which constitutes by far the predominant part of the solid structure of the muscle fibre and which is unanimously regarded as the contractile substance of muscle." Engelhardt's article gives a detailed description of the purification and crystallization of adenosine triphosphatase, and of the stimulating work of Szent-Györgyi and his colleagues in this field of muscle chemistry. The article not only deals with the characteristics of the enzyme activities of myosin but goes on to the discussion of "mechano chemistry", a term which is meant to embrace those physical, or physico-chemical, changes undergone by the contractile substance of muscle, which are related to its mechanical properties and which are induced by substances produced by the "functional metabolism of muscle tissue". It appears to be manifest that the union between myosin and its substrate, adenosine-triphosphate, brings about physical changes in the protein which are directly connected with muscle contraction. A new phase in our knowledge of muscle chemistry has opened up, and Engelhardt's article is a good introductory survey.

Muscle chemistry also forms the subject of an interesting article by Hoagland of the states of altered metabolism in muscle diseases. When it is realized that striated muscle makes up about 42 per cent of the total weight of the body, and that so much fundamental information concerning normal mechanisms in this organ is known, it seems strange, as Hoagland says, that so little should be known of the biochemical origins of muscle diseases. Hoagland describes succinctly what is known of the metabolic changes in muscular atrophy and hypertrophy, and the degenerative changes in muscle due to deficiency of vitamin E. He discusses, from the point of view of metabolism, the grave muscular diseases of myasthenia gravis, myotonia, familial periodic paralysis, and progressive muscular dystrophy.

Biological antagonisms between structurally related compounds form the subject of a stimulating article by Dr. D. W. Wooley. The biological competition between structurally related molecules, first discovered in the study of enzyme systems, has become of great importance in the search for substances that will affect the growth and metabolism of micro-organisms. The successes and the failures which have attended efforts to evolve microbial antagonists, by creating molecules the chemical structures of which are related to those of substances known to be essential for the metabolism of the bacteria, for example, the vitamins, are described by Hoagland. He indicates the various possibilities and limitations of the present lines of inquiry.

Dr. M. G. Sevag writes a long and interesting article (94 pages with 218 references) on enzyme problems in relation to chemotherapy, which cannot be adequately summarized here. The article should be read by all concerned with investigations of biological antagonisms, of the effects of biological inhibitors on enzyme systems, of adaptive enzymes, of mutations induced by toxic agents and of other relevant phenomena. Dr. Sevag states that it has been his aim "to present the action of toxic or bacteriostatic agents, mutations, resistance and immunity as interrelated processes in micro-organisms". He concludes that the experimental data pertaining to the action of toxic or bacteriostatic agents seems to show that their effects are primarily on the respiratory enzymes. His article, without doubt, merits close attention by all workers interested in the bearing of enzyme chemistry on chemotherapy.

Dr. C. E. Clifton presents an able summary of our present knowledge of microbial assimilation, the process in which synthetic operations occur in the cell simultaneously with breakdown (chiefly oxidative) processes. His objective is "to consider the studies dealing with the assimilatory processes of nonphotosynthetic micro-organisms and to attempt as far as possible to correlate observations on the relation between the anabolic and catabolic activities of microbial life". Dr. Clifton gives a detailed and valuable account of many experiments (including some of those of himself and his colleagues) on the oxygen consumptions of resting, or washed suspensions, of bacteria in presence of organic compounds and on the simultaneous assimilation of a portion of the substrate by these organisms.

All biochemists interested in the significance of acetyl phosphate in intermediary metabolism will do well to read Dr. F. Lipmann's article on this subject. Use of the isotope technique has thrown acetic acid into prominence as a probable source, in the body, of complex organic molecules. Lipmann's work on acetyl phosphate shows a possible way in which acetic acid is likely to enter into the synthetic operations of the cell.

Limitations of space forbid more than mention of the interesting article by Dr. K. C. D. Hickman and Dr. P. L. Harris on tocopherol interrelationships, in which they examine the physiological activities of the E vitamins in terms of oxidation control and conclude that α-tocopherol has a more fundamental function, at present not understood. Nor is there room to describe the lengthy (79 pages, 355 references) but most instructive article by Dr. Frankenburg on the chemical changes in the harvested tobacco leaf. Indeed, this article deals only with those changes attending the curing process; a later article will deal with the changes taking place during fermentation.

J. H. QUASTEL

MATHEMATICS OF STATISTICS

Mathematical Methods of Statistics

By Prof. Harald Cramér. (Princeton Mathematical Series, 8.) Pp. xvi+575. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 33*s.* 6*d.* net.

A First Course in Mathematical Statistics

By Prof. C. E. Weatherburn. Pp. xv+272. (Cambridge: At the University Press, 1946.) 15*s.* net.

THESE two books at once invite comparison with Maurice Kendall's "Advanced Theory of Statistics" and A. C. Aitken's "Statistical Mathematics". All four are mathematically flawless, and they all require from the reader some mathematical training and ability, but not to the same extent, nor are they all addressed to quite the same category of scientific workers. Kendall, in his preface, called his "a book on statistics, not on statistical mathematics" and declared his intention "to keep the mathematics to heel". Cramér's book (based on his Stockholm lectures since 1930) is very definitely for the mathematician, and its avowed purpose is to join the two lines of development due on one hand to the British and American schools of statisticians, and on the other to the rigorous work of French and Russian mathematicians in developing the calculus of probability. The first twelve chapters are a purely mathematical introduction, dealing with the properties of sets, Lebesque integrals, Fourier integrals, matrices and quadratic forms, and the like, preparatory to the later chapters on random variables, probability distributions, and statistical inference. The author advises the reader to jump to Chapter 13 after reading the first three chapters and a few other paragraphs, and thereafter to use this earlier part only as needed. The advice is good, and for my part I would say jump to Chapter 13 at once. Many who ought to read the book would be highly discouraged by the apparent irrelevance of those first three chapters, yet might turn to them without dismay later after seeing their use and necessity.

Weatherburn says in his preface, "the subject treated in the following pages is best described not as Statistical Methods but as Statistical Mathematics, or the mathematical foundations of the interpretation of statistical data". His book does not make such demands on mathematical ability as Cramér's, and is addressed more to practitioners. It is indeed based on lectures to graduates and undergraduates whose researches and studies were in agriculture, biology, economics, psychology, physics and chemistry. They cannot, however, have been a random sample of the students of those disciplines, I imagine. For those who can follow, however, Weatherburn's book is excellent. The chapter on the properties of Beta and Gamma functions, the use of which in discussing tests of significance is a feature of the book, thoroughly justifies the author's claim that it is clear and simple and does not demand any previous knowledge of these functions. Moment-generating functions are used quite a lot (as also by Aitken), in contrast to Cramér's book, where they are never mentioned except possibly in one exercise. I am surprised that the psychologists at least among Weatherburn's hearers did not ask for an earlier treatment of partial and multiple correlation. When he does come to them, he deals very neatly with the maximum correlation between one variable and the weighted sum of two others, and then simply directs attention to the validity of the argument also for *n* others. He does not mention, however, the problem of maximum correlation between two 'batteries' of variables, nor refer anywhere to Harold Hotelling. Neyman, too, receives only a passing reference, in a footnote, and Egon Pearson the same.

I mention these facts about Weatherburn's book not to criticize, but to assist the reader in knowing what to expect in it. Its great virtue is its compactness of argument, which facilitates seeing the whole. For example, he deals with fiducial limits in two paragraphs only, for the fiducial limits of a mean, using σ in the earlier paragraph, and its unbiased estimate s in the later; but the principle is shown clearly, though the words "fiducial limits, or confidence limits" on p. 122 rather suggest a confusion of the theories of Fisher and of Neyman–Pearson. Similarly, the term 'maximum likelihood' occurs only once in the book; but the paragraph which contains it (par. 77) puts the matter with extreme clearness. It may be, however, that anyone not knowing of its importance beforehand would pass over the paragraph without full appreciation. That is the danger of compactness and austerity. Kendall's book is warmer and more inviting.

In his Chapter 34, Cramér, after mentioning the two modern methods of outflanking Bayes' postulate, Fisher's *fiducial probabilities* and Neyman's *confidence intervals*, confines his treatment in the main to an account of the latter theory. In the succeeding chapter, on the general theory of testing statistical hypotheses, he deals further with the Neyman–Pearson theory and its basic idea of trying to reduce the chances *both* of rejecting a hypothesis when in fact it is true, and of accepting it when it is false.

On p. 520 Cramér begins a three-page discussion of the problem which leads to the Behrens test, namely, the problem of determining, from two independent samples, whether the means of two populations differ significantly, their standard deviations being also unknown and not necessarily equal. This is described, in Kendall's book, as a crucial problem for the rival theories of fiducial probability and confidence intervals. I speak with great diffidence, for the matter is difficult; but there does not appear to be any recognition of this in Cramér's book.

GODFREY THOMSON

PHASE-CONTRAST METHODS IN MICROSCOPY

By Prof. L. C. MARTIN
Imperial College of Science and Technology

IF we place, on the stage of a microscope, a slide coated with a thin but opaque metal film pierced by small apertures of distinctive shapes and sizes, there is no doubt as to how its image should appear. We expect to see a dark field surrounding bright areas geometrically similar to the apertures, though on a larger scale. Suppose, however, that the object is a very thin section of some biological structure, for example, a nerve with many component fibres. The various parts of the cellular structure have little difference in their relative transmission for ordinary light, and only differ optically in their refractive indices. What should the image look like ?

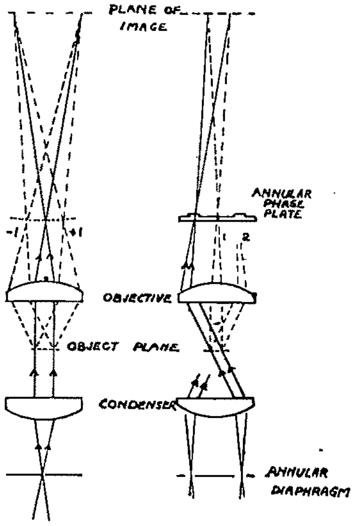
It is known from experience with the first type of object that the exact geometrical relations between object and image are most closely preserved when the numerical aperture of the illumination is adequate to fill the aperture of a perfectly corrected and truly focused objective ; but if we apply such conditions to the 'section', the image will probably give little indication of any object-structure. The microscope is then telling us that there are no considerable differences of opacity in this object.

It is possible to overcome the difficulty by resorting to methods of 'staining', or using, say, ultra-violet radiation of a wave-length for which the structures may show marked differences of transmission ; but both these methods are attended by certain difficulties and disadvantages which need not be detailed here. In spite of their great technical value, they are not always suitable or possible ; thus any method which uses ordinary light, and more or less ordinary microscope equipment, offers much attraction.

Familiar experience shows that if the aperture of the illumination is drastically restricted when viewing such a section, the image will show a pattern in which the distribution of light intensity has at least *some* geometrical relation with the structure of the object in terms of refractive index, but it is not generally clear how the image is to be interpreted in detail, apart from its broader features. Alternatively, dark-ground illumination may be employed, in which a pattern is obtained, again with some broadly similar geometrical features, but with marked differences in the expression of detail and with highly accentuated contrasts. In both images any relatively large areas of uniform thickness and refractive index will be rendered uniformly light and dark respectively in the cases of bright and dark fields; the brightness of the image changes only in regions where there are marked variations of optical path in the object.

Phase-contrast offers a means, within certain limits, of relating the brightness to the magnitude of the optical path and not merely to its changes.

Let us confine attention for the time being to a theoretical case in which the illuminating beam is 'parallel', that is, the numerical aperture is zero. Fig. 1*a* is intended to suggest how the direct light and the diffracted beams meet in the image plane. The diffracted beams are suggested by the broken lines. In such a case it was shown by Lummer that, if the objective aperture were large enough to take in *all* the light transmitted and diffracted by the object, the image would represent the object both in intensity and relative phase ; that is, we should see differences of brightness corresponding to the differences of transmission in the object ; and moreover, if some parts of the object cause a greater optical path than others, the light in the corresponding parts of the image would exhibit a proportionate retardation of phase. However, this is not immediately helpful as regards visual distinction, since the eye cannot pick out such phase differences ; it can only appreciate differences of brightness in the field.



(*a*) (*b*)

Fig. 1

One of the most interesting contributions to the theory of the interference of light which has been made in recent times is the suggestion of F. Zernike that we can render these phase differences visible by adding (or 'subtracting') a uniform background of coherent light. Where the phase of the background agrees with that of the field the brightness will be enhanced ; where the phases are opposite there will be a loss of light. We can look on the light leaving the object plane as 'the unaffected wave *plus* certain diffraction waves produced by the structures'. While the diffracted light is widely spread, the direct light will be brought to something approaching a physical focus in the upper principal focus of the objective before it spreads out to fill the image field and form (together with the 'diffracted' waves) this invisible image expressed in terms of phase variation ; but suppose we place in the focus of the direct beam a thin plate of phase-retarding material (a 'phase strip') so small in area that we can neglect without much error its effect on the diffracted waves. Once more we can apply the above idea ; the wave leaving the phase strip can be regarded as the incident wave plus a wave due to the strip. We thus add (in effect) a uniform background of coherent light to the original image, and the differences of phase of the image (corresponding to difference of path in the object) become visible as differences of brightness.

The above ideas may be symbolized in the vector diagram, Fig. 2, where *OA* represents the amplitude and phase of the incident wave ; it passes through a certain element of the object and is retarded in phase. The result is now represented by *OP*, which we can look upon as the incident wave *OA* plus the diffracted wave *OQ*. Again, the incident wave *OA* passes through the phase strip, where it is retarded by 90°

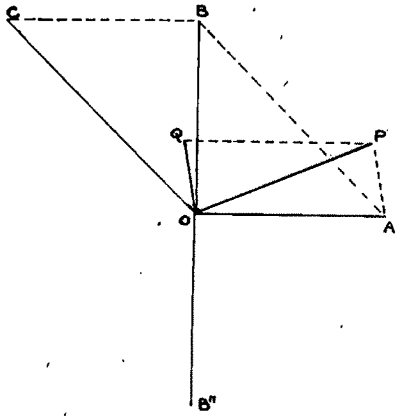


Fig. 2

thus becoming OB (note that OQ is regarded as unaffected). Now OB can be represented by OA plus OC. Thus the final effect can be looked on as due to: (*a*) the incident wave (unaffected) (OA); (*b*) the 'wave' generated by the element (OQ); (*c*) the 'wave' generated by the phase strip (OC). We can look on the 'wave' OC as adding the 'uniform background of coherent light'. In effect, of course, the resultant is the sum of OQ plus OB. This summation is effected in Fig. 3*a*, where the resultant amplitude is represented by OR. Suppose now that various parts of the object exhibit regions of small phase-changes for which the 'diffracted' waves in the above sense are OQ_1, OQ_2, OQ_3, etc. (Fig. 3*b*). Then when the original wave has been subject to the 90° phase change the resultants will be OR_1, OR_2, OR_3, and the corresponding intensities in the image will correspond to the squares of these amplitudes. We shall now have a *differing intensity corresponding to the differing phase*, and this is an important gain. The *relative* differences can be enhanced if the amplitude of the direct beam is cut down at the same time that its phase is changed (this can easily be effected by suitable absorbing material, see below). Then its amplitude can be represented by the shortened line OB^1 (Fig. 3*c*), and the relative amplitudes of the final resultants by OR_1^1, OR_2^1, etc., which have a larger relative variation.

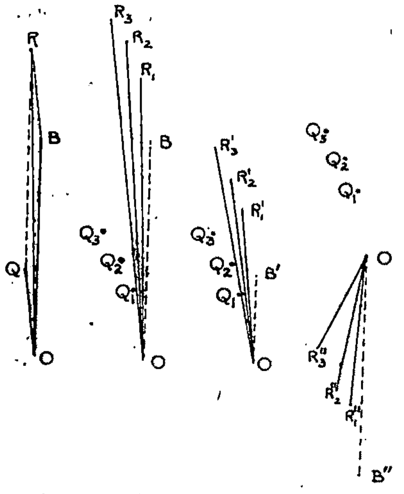


Fig. 3

Again, it is possible so to arrange matters that the phase of the direct light is accelerated with regard to the diffracted waves; then the vector OA (Fig. 2) is shifted to OB^{11}, and it will be clear that the resultants OR_1^{11}, OR_2^{11}, etc. (Fig. 3*d*), have reversed their relative order of magnitude. Hence the contrast is reversed, and the picture will be a negative of the previous one (negative phase-contrast).

The above considerations should help to make clearer the answer to the question which is commonly put regarding phase-contrast. It is this: We are told that in order to establish the best resolution in the image we should employ the widest possible cone of illumination; on the other hand, phase-contrast methods demand a drastic restriction of the numerical aperture of the illumination. Shall we not therefore lose resolution and therewith the truthfulness of the image?

In answer, it is admitted at once that if the object is one consisting mainly of opacity variation, then the best image is obtained by using the widest possible cone of illumination; if good contrast cannot be obtained with such illumination (as compared with the contrast of the object) then the spherical correction of the objective is suspect, or much stray light may be present. On the other hand, one can only speak of resolving power in relation to a 'phase-variation' object when some means exist of making the structure visible to the eye, with some ascertainable degree of geometrical verisimilitude. If we use a narrow aperture and very oblique illumination, we can, it is true, often obtain evidence of reasonably large phase-variation in fine-structured detail as readily as if a similar opacity structure were present, but if the phase-variations are small the possible brightness differences will be very small also. Using the Abbe principle, it can be said that generally if the angle of a parallel illuminating beam is reduced from the greatest possible obliquity to a direction parallel to the axis, the minimum resolvable interval for a regular structure is increased by a factor of approximately 2; but this depends entirely on the presence of a phase-variation in the object of adequate amount; if the phase-variations are very small, there may not be sufficient contrast in the image to obtain visual resolution of the structure in either case. The discussion of the resolving limit for phase-variation structure has thus no meaning apart from the specification of the phase-angles concerned; for these determine the possible visual contrast.

According to Zernike, phase-contrast has no special use where large phase-variations, say 180°, are concerned; it will, on the other hand, easily render visible phase-differences of very small angle, say 5°–10°; moreover, the phase-step is seen as a step of brightness between two uniform corresponding parts of the field, not merely as a halo or dark fringe.

It need not, therefore, be feared that the phase-contrast method must always result in a 'loss of resolution'; unless, indeed, the object is one of mixed opacity and phase-variation, which is a case requiring special study.

In practice, the simplest arrangement for producing phase-contrast would require a central circular aperture stop in the lower focal plane of the condenser; this would produce a roughly parallel beam through the object. The phase-plate then occupies a position, in the upper focal plane of the objective, conjugate to the aperture stop. In order to increase the light available for the image, the stop can be elongated to a broad slit; but directional differences then become

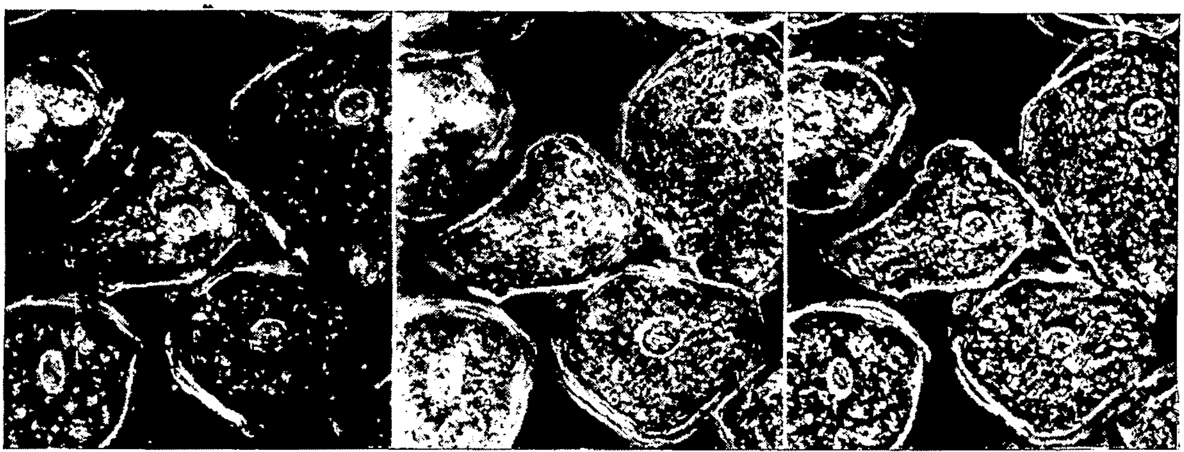


Fig. 4. COMPARATIVE PHOTOGRAPHS OF EPITHELIAL CELLS FROM THE MOUTH. OBJECTIVE, COOKE 4 MM., N.A. 0·65 ; EYEPIECE, COOKE, × 6 ; BELLOWS EXTENSION, 40 CM. ; MAGNIFICATION, × 300. (a) DARK-GROUND ; (b) POSITIVE PHASE-CONTRAST ; (c) NEGATIVE PHASE-CONTRAST. REPRODUCED BY COURTESY OF MR. E. WILFRED TAYLOR

manifest. In practice the most satisfactory form of the condenser stop is thought to be an annular aperture having a mean radius corresponding to about $\frac{1}{2}$ to $\frac{2}{3}$ of the numerical aperture of the objective, and a width about $\frac{1}{15}$ of this aperture. The phase-plate then has a corresponding phase-changing ring, as suggested in Fig. 1*b*. This arrangement is intended to minimize any loss of resolution.

A retarding ring can be made by vacuum deposition of some suitable material, say calcium fluoride, on the surface of a plane parallel plate; such a ring will usually require protection. Rings can be etched into a similar plate with dilute hydrofluoric acid; and we can thus obtain plates in which the diffracted components suffer greater retardation than the direct light; this is equivalent to an acceleration of the direct light, and would give negative phase-contrast.

If it is desired to diminish the intensity of the zero-order component, the area of the phase-ring only may be coated with a thin film of metal, say, aluminium, by vacuum distillation.

Alternatively, strips or rings of the desired form can be cut from nitro-cellulose, gelatine, etc., which can be made 3μ–6μ thick; these may be cemented in a medium having a refractive index differing somewhat from that of the strip. A very precise control of the retardation is thus possible. Gelatine strips can be dyed to give more or less neutral or selective absorption. The upper focal plane of low-power lenses can be furnished with a thin glass plate bearing a suitable ring; but this arrangement will not serve for high powers, where the principal focus may lie within the lens; in such a case the phase-ring may be borne by one of the interior surfaces. It is thus a considerable advantage to have a special set of objectives fitted with such phase-rings. They will not be ideal for use apart from the phase-contrast method, but at any rate if the phase-ring is non-absorbing the disturbance to the phase-relations in an ordinary image will correspond to the well-known 'Rayleigh Limit', which roughly marks the bounds of discriminable effect. Objectives so fitted can be thus used for ordinary purposes with little risk.

Messrs. Cooke, Troughton, and Simms, Ltd., of York, are producing special sets of objectives, together with the accessory condenser apertures, etc., and the method was recently explained and demonstrated by Mr. E. Wilfred Taylor at a meeting of the Royal Microscopical Society. He showed photographs of biological objects involving the discrimination of extremely small path-differences in flagellæ, etc., which were clearly brought out by phase-contrast. It was clear from such photographs that the images obtained may differ considerably from those obtained by normal methods, and careful attention to the interpretation will be necessary.

Still more recently, Mr. Taylor has made and described a new phase-contrast microscope in which a controlled variable amplitude for the 'direct-light' component is obtained. It is thus possible to adapt the instrumental conditions to suit various types of phase-variation in the object detail. Polarized light is employed, and the necessary relative amplitude variation is secured by the use of a plate, built from concentric annuli of right-handed and left-handed quartz, to carry the phase-changing annulus in the upper focal plane of the objective.

It may be possible perhaps to develop some scheme whereby artificial phase-step objects can be made and included in microscope slides of objects to be studied; the photometric scale for such steps could then be established in terms of the corresponding path differences; this would (for a section of known thickness) enable an approximate determination of relative refractive indices to be carried out, which would be a step towards the identification of parts of the structure. Methods of an analogous kind are well known in connexion with doubly refracting materials. The 'artificial objects' could be minute crystallites or photographic step-wedges in gelatine, etc., mounted in balsam of suitable refractive index.

It cannot be said that the practical use of phase-contrast is yet as fully understood as it should be. The theory rests largely on a two-dimensional analysis; even so, it is only partly developed and the exact effects of the annular phase-contrast rings have not yet been fully explored. During the discussion at the Royal Microscopical Society, Mr. J. R. Smiles, of the National Institute for Medical Research, mentioned difficulties in interpretation of the image due to scattering of light by the object. If the object is an infinitely thin lamina, then the 'scattered' light has the phase characteristics of diffracted light, and consists of the boundary waves, etc., generated in the object plane as well as any light suffering molecular scattering; the effects of this are more or less predictable; the waves are diffracted at the circular aperture of the objective, and the phase-strip contributes its effect also. The general effect is to form fine halo and shadow fringes near the boundaries of phase-change in the object. Zernike has discussed similar effects in his papers, showing how it is that small opaque particles may sometimes appear bright on a dark ground, drawing their light from neighbouring parts of the field.

But the problem grows much more complex when the object is thicker; the sum of the diffracted light may have no easily predictable phase-relation with the incident light, and could thus be spoken of as 'scattered' in that special sense. The halo and fringe effect may therefore be complex, and although the broader regions of uniform phase should still be rendered at the appropriate brightness levels in the image, we cannot interpret the fringes in the same way in every case. The statement above, that the brightness of the image field is related to the retardation of the object, does not apply to the variations of brightness in the border fringes, and the possibility of estimating the retardation does not apply to relatively small objects.

Enough has been said to indicate that the practical technique must be studied in relation to special objects. The simple theory only takes the worker a part of the way, and there is room for a considerable amount of further work both theoretical and practical. However, all the evidence shows that 'phase-contrast' is a most valuable addition to the methods available to the microscopist, and it is being intensively studied at the present time. One of Zernike's own papers (*Physica*, 9, 686 and 974; 1942) gives the best starting-point.

MARINE BIOLOGY AT PLYMOUTH*

THE Marine Biological Association of the United Kingdom came into being in 1884 as a result of a meeting held under the chairmanship of Prof. T. H. Huxley, the successive outcome of which owed much to the initiative and energy of Sir E. Ray Lankester. The prime purpose of the Association was "the establishment and maintenance of a well-equipped laboratory at a suitable point on the English coast, similar to, if not quite so extensive as, Dr. Dohrn's Zoological Station at Naples". The suitable point finally selected was Plymouth, and there, under the walls of the Citadel built by Charles II and overlooking the waters of Plymouth Sound, the laboratory building, constructed of the same Devonian coral limestone as the Hoe, was opened on June 30, 1888.

Financial support came initially from members of the Association, from universities and other public bodies, notably the Fishmongers' Company, and from H.M. Treasury. All these sources of income have been maintained and increased, but especially the Treasury grant, which became considerable after 1918, when it was put under the control of the Development Commissioners. In 1902 the Association undertook the British share of the scientific investigations of the International Council for the Exploration of the Sea, which involved the establishment of a second laboratory at Lowestoft for work on the trawling grounds and food fishes of the southern North Sea. After 1918 this laboratory was re-established under the Ministry of Agriculture and Fisheries for work on problems dealing directly with commercial fisheries. The Plymouth Laboratory was to be concerned with the more fundamental problems of marine research, and to this end notable increases were made to the staff, buildings and facilities of the Laboratory in the years between the two World Wars.

The papers published in the *Journal* of the Association, now in its twenty-sixth volume with two earlier volumes in a smaller format, indicate the changing interests and widening scope of the work carried on in the Laboratory. Earlier volumes are largely concerned with observations on the habits of fishes and shellfish and on the methods and results of commercial fisheries. Aided by enthusiastic visiting workers, the basis was also being laid of the extensive knowledge of the marine life of the Plymouth area now recorded in the "Plymouth Marine Fauna" (second edition, 1931). With the assumption of the work for the International Council opportunities came for initial studies on hydrography, on bottom fauna and on plankton. A notable change comes in the subject-matter of the *Journal* after 1918, with emphasis on the study of the chemical and physical conditions of the environment, on the life-histories and development of marine invertebrates and on the distribution in space and time of the animal populations. Nevertheless, research on the biology of fishes continued and provided a necessary link with the more economic investigations being carried out at Lowestoft. But recognition of the value of fundamental research had been achieved. To-day we are approaching the stage when all fisheries research will become increasingly fundamental, aimed at understanding the great natural fluctuations in the fish populations and the causes of the habits of the fish themselves.

The Plymouth Laboratory has provided the basis for such far-reaching studies by the concentration of its work around two main themes. The first is how much living matter can the sea produce, what are the variations and causes of variation in productivity, and how do the organisms obtain the materials necessary for life? The second is how do marine animals live, how do they fit their various environments, and what alterations in the conditions in their environment can they appreciate? The sea water contains all the ingredients needed for successful growth and development of living organisms; it is the conditions in the water which therefore determine their distribution and migrations.

The study of the physics and chemistry of the sea has thus become a major preoccupation. The approximate yearly cycle of the more abundant constituents —phosphorus, nitrogen and silicon—is now known, although much remains to be done on the annual turnover and on periodic fluctuations. This in turn involves a study of water movements, especially of upwelling from deep layers. Plant life depends on light and is limited by the depth of its penetration; this is being studied by methods employing photoelectric cells. Meanwhile, pure cultures of diatoms and flagellates are used as experimental material for determining the utilization of combined nitrogen and phosphorus, and the effect of trace elements such as iron and manganese, which may limit plant production in the sea.

Animal plankton forms the first link of the chain from plant plankton to fish, and researches on its distribution, abundance, growth and habits form a necessary part of the study of the general problem of productivity. The effects of grazing off the plant crops can be studied at sea by evaluation of their numbers in measured volumes of water and also experimentally in the laboratory. Certain species of plankton organisms are restricted to certain types of water, and form most valuable biological indicators of their respective water masses, which are often not easily distinguishable by the usual hydrological features, such as salinity and temperature.

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* Substance of a lecture by Wing-Commander F. S. Russell, F.R.S., delivered at the Royal Society on March 6.

Bottom-living invertebrates form the food of many fish and are specialized for life in different grades of bottom material, from fine mud to coarse gravel, and normal metamorphosis from the larval stage may only occur on the appropriate substratum. Study of the available food in the different deposits reveals considerable variations. The topography of the sea bottom is also important in connexion with water movements. There are indications that the embayments resulting from submerged valleys may cause submarine waves, with consequent upwelling of nutrient-laden water into the photic layers.

With the exception of insects, all the major groups of animals are represented, many of them exclusively, in the sea. The problems they present for inquiry to the systematist, morphologist, ecologist, parasitologist, embryologist and geneticist are without limit, and so, from this point of view, are the facilities of the Plymouth Laboratory. From a study of structure there is a natural transition to that of life-histories, food and feeding, breeding and growth, and the general relationships between the animal and the environment. Apart from the bearing of such studies on food fishes and shellfish, they provide essential knowledge for combating the activities of marine boring animals and of fouling organisms. During the War the demand for raw material, such as alginic acid, agar and mannitol, from seaweeds, gave a sudden stimulus to research on the life-history and growth-rate of intertidal weeds, of which very little was known. Extension of work into estuarine waters has provided physiological problems of the first importance and data of value in assessing pollution. Finally, by the working out of new methods of collection and analysis, the Laboratory has played an important part in the success of deep-sea expeditions carried out by vessels of many countries.

While the work of the staff at Plymouth is most varied, as revealed in the foregoing brief survey, it is greatly increased by that of the continuous stream of visiting workers from all countries which has always been encouraged in every way possible. To them in particular has been due the increasing volume of physiological work for which the rich supply of animal life provides material often unobtainable elsewhere, such as the spider crab, *Maia*, used for nerve physiology and studies on the respiratory pigment, hæmocyanin, the squids and cuttlefish with their giant nerve fibres, sea anemones with their simple nerve net, and the dogfish which has provided material for elucidation of the function of the lateral line and of the labyrinth.

From the simple beginnings of accommodation, staff and programme in 1888, the Plymouth Laboratory has been gradually raised to its present commanding position among research institutions, above all by the careful guidance of Dr. E. J. Allen, its director for forty-two years, and of his successor for an all too brief period, Dr. Stanley Kemp. With their names will always be associated that of Dr. G. P. Bidder, who has given so generously in wisdom and money. The present buildings can accommodate some forty workers, including the present twelve members of the permanent staff. It possesses an admirable library and an aquarium. There are two research vessels, a 25-ft. motor boat and a 90-ft. motor fishing vessel used for investigations at sea and also for collection of specimens and for stocking the aquarium. During the Easter vacation, they also assist in the courses for students which are so important a feature in the work of the Laboratory, and which have guided many young zoologists into a life-work of fruitful research either in the universities or in marine laboratories.

The Plymouth Laboratory, in the words of its present director, F. S. Russell, "aims to give facilities for any research, not necessarily only biological, on problems for which the sea can provide the materials or the environment required. Its position is unique, lying as it does between the extremes of a fishery research laboratory and of an oceanographical institution, yet serving both, and at the same time offering facilities for visitors like the laboratory at Naples on whose pattern it was first founded. Let us hope it may continue to hold this focal position and attract all those interested in the science of the sea and indeed of life itself."

THE VIENNA ACADEMY OF SCIENCES (1847–1947)

THE "Kaiserliche Akademie der Wissenschaften" of Vienna was founded by Kaiser Ferdinand I on May 14, 1847. Although not a State institution, the Academy is conducted under the ægis of, and is endowed by, the State. It consists of two Sections (Klassen), the Mathematical and Natural Science Section for mathematics, natural science, medicine and technical science, and the Philosophical and Historical Section for philosophy, history and archæology, art and music, language and literature, geography and ethnology, law, political science and economics. The Sections meet separately every fortnight for the consideration and discussion of scientific subjects, and they have a joint session once a month.

The work of the Academy is carried out under the continuous supervision of a commission for each scientific subject or for a particular research undertaking, this commission advising on the equipment, methods and problems of the undertaking, and on the choice of suitable personnel. From the scientific point of view, the main work of the Academy is under the care of its members, and it maintains a scientific liaison with various State institutes, in particular with those of the University of Vienna. Moreover, the Academy has several institutes under its direction, especially on the scientific side.

Each Section of the Academy has 33 members and 80 corresponding members, of whom 35 are Austrians and 45 foreign nationals, and there are also 8 honorary members in each Section. Provision is also made for the election of eight honorary members of the whole Academy, and these would be mostly highly placed dignitaries of the State who have rendered service to research or to the advancement of the interests of the Academy, or distinguished men of learning of national or international repute. Corresponding members are entitled to take part in open meetings of the Sections, but they are not automatically promoted to full membership of the Academy. Places rendered vacant by the death of members or corresponding members are filled at the annual elections, and membership is only possible by election.

During the past hundred years, the activities of the Academy have been many and varied. In the Mathematical and Natural Science Section, a beginning was made in 1849 with meteorological observations in Austria, and these laid the foundation for the establishment of the Zentralanstalt für Meteorologie und Geodynamik, now a State institution, but with which the Academy still maintains close scientific connexion. Measurements of gravity in Austria in relation to geotectonic structure have been carried out, a magnetic survey of the country has been made, and investigations on atmospheric electricity have been undertaken. Furthermore, the Academy has taken part in Polar expeditions and fitted out the station on Jan Mayen Island (off Greenland) in the years 1882–83 and 1932–33. In the years 1867–79 investigations of a hydrographic and physical nature were carried out in the Adriatic, and during 1890–98 expeditions were sent to the Eastern Mediterranean (north of Crete), to the Sea of Marmora and to the Red Sea for hydrographic and geophysical observations, for the chemical and physical investigations of the water, and for the collection of zoological specimens. In 1901 a botanical expedition was sent to Brazil, and one for zoology in 1903.

On the scientific side, the Academy administers wholly or in part a number of research institutions. The Institut für Radiumforschung (Vienna Radium Institute) was founded in 1910 and possesses 4 gm. of radium chloride for research purposes. From among its past activities may be mentioned the provision and certification (jointly with Paris) of radium standards, the development of methods of measurement, investigation of the various radioactive radiations and the effects of radioactive substances, the isolation and properties of the radio-elements, and work on isotopy. The years between the two World Wars were characterized primarily by K. Przibram's work on crystal physics, and a large amount of work was done in the Institute on problems connected with artificial transmutation (by Pettersson, Kirsch, Ortner, Stetter, Blau and others). At the Biologische Versuchsanstalt in Wien (Prater), experimental zoological and botanical work was carried out between 1913 and 1941, more especially on *Entwicklungsmechanik* and research on regeneration. The Station was damaged during the War, and its director and co-founder, Hans Przibram, was a war victim and died in a concentration camp. The Biologische Station in Lunz investigates the plant and animal world from the point of view of biology and ecology in the three Alpine lakes and in the neighbourhood accessible from the Station. The Academy also has Höhenobservatorien (mountain observatories) on the Sonnblick (Hohe Tauern, 3,100 m.), and on the Obir (2,000 m.) in the Karawanken, south-east of Klagenfurt.

The Philosophical and Historical Section of the Academy has conducted research in the field of Austrian history back to prehistoric times. It has carried out prehistoric excavations and investigations on monuments from Roman times, and has published "Quellen zur österreichischen Geschichte" (Sources of Austrian History) dating back to the early Middle Ages. Between 1900 and 1910 research expeditions were sent to Southern Arabia for linguistic purposes, and likewise to Palestine and Transjordan for archæological studies. It has also published a *corpus* of ecclesiastical writers in Latin, as well as records of Greek and Roman inscriptions of Asia Minor resulting from journeys of exploration in that region. Furthermore, excavation of an extensive cemetery near Giza, in the neighbourhood of the Great Pyramids, yielded important results on the history of architecture and sculpture of the Old Kingdom in Egypt. Linguistic and archæological investigations in the Balkans have have also been undertaken.

Among the institutes under the control of the Academy there is also a Phonogrammarchiv (Gramophone Library), equipped with the most modern methods of recording, and here are housed a large number of speech records of most of the world's living languages, vocal 'portraits' of important historical Austrian personages and representatives of the stage, together with interesting medical records on rare defects in speech.

In the realm of natural science, the Academy has the names of many distinguished men of science on its roll, including the mathematician Wilhelm Wirtinger, the physicists Loschmidt, Boltzmann, Franz Exner, Ernst Mach and Stefan, the chemist Auer von Welsbach, the geologist Eduard Suess, the botanists Richard Wettstein and Hans Molisch, and the medical scientists Karl Rokitansky (pathological anatomist), Sigmund Exner (physiologist) and Theodor Billroth (surgeon).

The Academy issues the following publications: *Denkschriften der Gesamtakademie* (Vol. I: History of the Academy, 1847–1947, by the present vice-president, Prof. R. Meister), *Almanach* (annual reports of the Academy), *Anzeiger* (preliminary notices) of the two Sections (annual reports of activities). Scientific papers in each Section are published in *Denkschriften* and in the *Sitzungsberichte*.

It is not generally known that the Vienna Academy rendered incalculable service in two directions in the early days of radioactivity. When it was realized that there were other radioactive substances than uranium and thorium present in pitchblende, it seemed probable that these would be found in the uranium residues resulting from the extraction of uranium, of which large quantities lay derelict at St. Joachimstal in Bohemia. The French approached Suess, who was president of the Academy at the time, and through his intervention with the Ministry of Agriculture, two wagon loads of the residues were dispatched free of charge to Paris. It was from this material that the Curies isolated the element radium and prepared the Primary International Radium Standard, and it has been estimated that 60,000 kgm. of these residues contained a total of about 24 grams of radium. The second instance concerns the loan by the Academy of about 400 milligrams of radium to the late Lord Rutherford; it was primarily with this material that most of the work of the Rutherford Schools at Manchester and Cambridge was carried out. After the First World War, Lord Rutherford purchased this radium from the Academy in annual instalments, and as a direct result the Vienna Radium Institute was enabled to carry on through the first lean years of peace.

On the recommendation of Prof. H. Mache, of the Technical High School, it was my happy privilege to work in the Vienna Radium Institute during 1913–19. That grand old man of science, the spectroscopist Franz Exner, lovingly known as 'Väterchen', was the representative of the Academy in the Institute, and Stefan Meyer made an ideal director. It is good to know that, after a break of several years, he is again directing the Institute, and that Karl Przibram is also there. Imbued with the spirit of the Exner School, Meyer was ever ready to place at the disposal of his fellow-workers his stimulating ideas and great wealth of experience as a pioneer and fruitful worker in the field of radioactivity. At the outbreak of war in 1914, and with the backing of the Academy, he successfully appealed for my release as a civilian prisoner of war, and as a result my work in the happy family atmosphere of the Institute continued throughout hostilities. During these years much of the pioneer work on isotopy and on tracer elements (radioactive indicators) was carried out in the Institute (Hevesy and Paneth), and the atomic weights of lead of radioactive origin and of other radioactive elements were accurately determined by Hönigschmid. Several Polish refugees worked in the Institute at that time, including Godlewski, Loria and Patkowski. Work on the counting of radioactive rays was actively pursued, mainly in collaboration with the chief assistant, V. F. Hess, discoverer of cosmic rays (1912). It is of interest to note that two of the members of the Institute later received the Nobel Prize (Hess and Hevesy), the latter also being elected a foreign member of the Royal Society, and quite recently Paneth (now at Durham) has been elected to fellowship of the Society. I shall be ever grateful for the friendly and cordial way in which I was received into the fellowship of the Radium Institute of the Academy, the stimulating and fertile influence of whose members was alone responsible for my being able, as an enemy alien in those eventful years, to publish twenty-three scientific papers, sixteen of which were presented to, and accepted without hesitation by, the Academy for publication in the *Berichte*.

I have much pleasure in acknowledging the help given me by the vice-president of the Academy, Prof. R. Meister, who supplied much of the information contained in this article. I am also indebted to Akademierat Dr. W. Oberhummer and to my old friend Hofrat Prof. H. Mache for additional information.

ROBERT W. LAWSON

CENTENARY CELEBRATIONS

The centenary of the Academy was celebrated in Vienna during the week beginning May 11. After the reception of guests in the Academy on the previous evening, the proceedings began on Monday, May 12, with a meeting of the Historical and Philosophical Section. The meeting was opened by the vice-president, Prof. Richard Meister, and after submitting the report of the Section, the general secretary, Prof. Josef Keil, described the work of the Austrian Archæological and Philological Expedition to the Balkans, Asia Minor, Arabia and Egypt. In the evening, there was a performance of Hoffmansthal's "Jedermann" given in the Ronacher Theatre, since the Burgtheater had been damaged by bombing. The meeting of the Mathematical and Science Section was opened on the following day by the president, Prof. Heinrich Ficker, and after the report had been presented by the secretary, Prof. Adalbert Prey, a historical account of the meteorological and geophysical work of the Academy was given by Prof. Ficker.

On May 14 the main ceremonial meeting was held in the great hall of the Academy. The ceiling, which had been damaged by water, has been restored, and this hall, with its magnificent baroque interior, made a fine setting for the distinguished gathering. The president of the Academy, in opening the ceremony and in welcoming the guests, pointed out that the Academy, which once belonged to a great country, now belongs to a small one, but that he hoped it would maintain, on the intellectual level, the characteristics of a great country. The President of Austria, Dr. Karl Renner, who had recently been elected an honorary member, then addressed the meeting, and stressed the importance of the freedom of science and research, and its independence from political influence or ideas. The Austrian Chancellor, Dr. Leopold Figl, then spoke. He referred to the role of Austria in the past as a mediating influence between East and West, and hoped that, in the present times, this could be taken up again. After a speech by the Minister of Education, Dr. Felix Hurdes, the congratulatory addresses from foreign societies were presented. In spite of the difficulties of travel, a number of learned societies sent delegates to attend in person: these included the British Academy (Sir Charles Webster); Royal Academy of Brussels (Prof. Henry Gregoire); Cambridge Philosophical Society (Dr. F. P. Bowden); Czech Academy of Sciences (Dr. Viktor Trkal); Papal Academy of Sciences, Rome (Prof. Ernst F. Petritsch); Paris Academy of Sciences (Prof. Charles Jacob); Polish Academy of Sciences (Prof. Tadeusz Kowalski); Swedish Royal Academy of Sciences (Dr. Orvar Nybelin); Swedish Royal Scientific Society (Prof. Einar Löfstedt); Swiss Academy (Prof. A. von Muralt); and Hungarian Academy of Sciences (Prof. S. Domanovsky). Congratulatory addresses and telegrams were also received from learned societies throughout the world.

The president then announced the election of new members and the award of prizes. Dr. Karl Renner was elected the sole honorary member of the whole Academy. Of the Mathematical and Science Section, J. Radon and W. Schwarzacher were elected full members; E. Hubble and P. Niggli, foreign honorary members; Sir Henry Dale, A. Ernst, O. Hahn, E. Hertzsprung, H. Pettersson and F. Vening-Meinesz, foreign corresponding members. Of the Philosophical and Historical Section, R. Köstler and K. Mras were elected full members; A. Dempf, I. P. Dengel and C. Rauch, Austrian corresponding members; P. F. Jouguet and Gilbert Murray, foreign honorary members; and C. Borren, B. Croce, S. Eitrem, H. Kelsen, G. Mercati and C. Samaran, foreign corresponding members. The Grillparzer Prize was awarded to Rudolf Holzer; the Fritz Pregl Prize to Heinz Holter; the Haitinger Prize to Prof. Berta Karlik, who worked for a time at the Royal Institution, London; and the Rudolf Wegscheider Prize to Prof. Alfons Klemenc. The meeting closed with an account, given by the vice-president, Prof. Meister, of the history of the Academy during the hundred years of its existence; the first award of the Jubilee Prize was made to him for his "Geschichte der Akademie der Wissenschaften in Wien, 1847–1947".

In the evening, there was a special performance by the State Opera Company of "Figaro", given in the Redoutensaal of the Hofburg. It was a remarkable performance, sparkling with life and gaiety, and it seemed typical of the gay courage of the Viennese and Austrian people that such an art could flourish in spite of the present hardships and the distress and misery of the past few years. On May 15 there was an excursion to the Benedictine Monastery at Melk, and to the Biological Station at Lunz. The Station is beautifully situated near the lake in the hills, and the surrounding fields were thick with wild narcissi and spring flowers. On the last day there was a visit to the National Library, followed by a lunch on the Kahlenberg, given by the Mayor of Vienna, and a farewell gathering in the evening in the Rathauskeller.

The visiting delegates naturally found great pleasure in establishing once more normal human relationship with their colleagues, and took the opportunity of visiting their laboratories. Even in the buildings which have not been damaged, the difficulties of carrying on with work are considerable. The problem of fuel for heating the buildings and laboratories throughout the severe Viennese winter is a serious one. Last winter, for example, in the physical and chemical laboratories, no fuel was available; and unless some can be obtained for the coming winter, much of the practical teaching and of the research work must again come to a standstill. No apparatus can be obtained to replace that which has been destroyed or stolen, and the lack of chemicals and the impossibility of getting any is a severe handicap both to teaching and to research. In all departments, the inability to get current publications or books from other countries is considered to be one of the most urgent problems. Action on this is being taken by the British Council and other bodies, but this necessarily takes time, and at the moment there is very little scientific literature available. It was impressive to see how the pursuit of knowledge and the arts, and interest in things of the spirit, took precedence over the material discomfort and struggle of living.

The celebrations were an unqualified success, and, considering the grave material difficulties, it was a remarkable achievement on the part of the secretaries of the Academy and the organisers. There is no doubt that the success owed much to the genial and commanding personality of the president, Prof. Ficker. F. P. BOWDEN

OBITUARIES

Prof. H. S. Jennings

THE death of Prof. H. S. Jennings, just after his seventy-ninth birthday, at Santa Monica, California, on April 14, has removed the most venerable figure from the ranks of students of the physiology and genetics of the Protozoa. His passing marks the end of an epoch.

Herbert Spencer Jennings, son of George Nelson Jennings, was born at Tonica (Illinois) on April 8, 1868. He graduated B.S. at Michigan in 1893, and afterwards held several different posts in other American universities. He took the degrees of A.M. (1895) and Ph.D. (1896) at Harvard, and after further wanderings settled at Johns Hopkins. Here he was appointed professor of experimental zoology in 1907, and became director of the zoological laboratory three years later (1910). He occupied this position with distinction until his retirement as professor emeritus in 1938, when he went to prolong his life's work—as a 'research associate'—at the University of California at Los Angeles. His name is therefore especially linked with Johns Hopkins, though he worked in many other places and received degrees and honours from many other American universities. His first wife—he married twice—was Louise Burridge, who assisted in the illustration of his publications.

During 1896–97 Jennings studied at Jena under Max Verworn, whose "Allgemeine Physiologie" (first published in 1894) was then arousing much interest among zoologists. Verworn was a pupil of Haeckel, and his book was not inaptly labelled by Rádl "the first—and probably also the last—Darwinistic physiology". Yet there can be little doubt that Jennings's brief residence in the stronghold of Haeckelism favourably influenced all his subsequent researches. After numerous preliminary papers he finally produced—while at Philadelphia—his famous "Behavior of the Lower Organisms" in 1906; and this is now generally accepted as a classic of protozoological physiology.

His studies on the physiology of *Paramecium* gradually led Jennings to investigate variation and heredity in this and other ciliates. A long series of papers—from 1907 until the end of his life—records the results of his accurate and admirable experiments. It is impossible to review these here, but most of his general conclusions will be found in his book "Life and Death, Heredity and Evolution in Unicellular Organisms" (Boston, 1920), his review "Genetics of the Protozoa" (*Bibl. Genet.*, vol. 5, 1929), and the article on "Inheritance in Protozoa" which he contributed to "Protozoa in Biological Research" (edited by Calkins and Summers, 1941; reviewed in *Nature*, vol. 149, p. 149; 1942).

Jennings's own labour, and that of his many pupils in similar fields, covered a restricted area but dug very deeply. It is still doubtful, however, how far their findings, in the intensive study of such highly specialized and peculiar organisms as the Ciliata, can be utilized for generalization in the larger domain of genetics. But taken as a whole, the extensive published work of H. S. Jennings does not belie the promise in his forenames: it is all distinguished by a sound philosophical outlook and profound appreciation of the value and scope of scientific method. Consequently, much that he did and wrote will withstand the test of time; and though all his conclusions may not ultimately prove correct, his experiments and his reasonings will undoubtedly endure as a solid basis for the researches of a newer generation. CLIFFORD DOBELL

Mr. G. H. Tipper

GEORGE HOWLETT TIPPER was born in Kendal in 1881, and educated at Kendal Grammar School and Clare College, Cambridge. He entered the Geological Survey of India in 1902. Apart from service in many parts of India, he went to Burma, the Andaman and Nicobar Islands; he travelled through Baluchistan and across Persia and spent three years in Chitral. During the First World War he served with the Bikanir Camel Corps in Egypt and the Libyan Desert and was in France for a short time. He was eventually recalled to help with the production of mica, a mineral in which he had already specialized. From this time he became keenly interested in its mining and preparation for industry, working at the mines themselves and even learning the technique of trimming and splitting.

Tipper had several severe attacks of malaria while abroad and retired after twenty-five years service in 1927. After visiting mica mines in Rumania and a period of travel in Canada and the United States, he married Dr. C. F. Elam, the well-known metallurgist, and retired to Cambridge with the view of working on the fossils he had collected in Chitral. However, he was soon invited to act as a minerals adviser to the High Commissioner for India, where his wide experience and exceptional memory were invaluable.

At the outbreak of war in 1939, Tipper went for a short time to the Department of Economic Warfare and thence to the Ministry of Supply as 'the acknowledged expert of experts' on mica. In 1941 he went as a representative of Great Britain and the Government of India to the United States to help in the organisation of supplies of mica on both sides of the Atlantic, and was attached to the British Raw Materials Mission in Washington. Altogether, he made the double crossing of the Atlantic four times during the War; he flew to India via New Zealand and Australia and also to Brazil. This last trip was a particularly arduous one. On his return to Great Britain, he continued at the Mica Control and eventually became director, until he was compelled to resign on account of ill-health in October 1946. His services were so much valued by the Board of Trade that he was retained as a consultant until his death on April 23, 1947.

Tipper combined the rare qualities of the trained geologist with an intimate acquaintance of the mica trade in all its aspects; but he could not have carried out his war-time work with such success if his complete honesty had not made him trusted and liked by everyone. His devotion to his work compelled him to embark on a series of journeys which many a younger man would have found exhausting, and kept him at work when he was already in bad health. One of his colleagues writes: "I don't suppose that the State ever received more selfless service from a man of great ability than England got from him".

Dr. Leopold von Portheim

The botanist, Dr. Leopold von Portheim, died in London on May 21. He had been seriously ill for some time. Portheim was born in Prague on February 7, 1869, and studied botany there and at Vienna, where he was a pupil of Dr. Julius von Wiesner. He thus lived to be one of the last surviving botanists who were trained by this great master.

One of the most notable achievements in which Portheim took a leading part was the foundation of the Biologische Versuchsanstalt in Vienna in 1901. In this he was associated with Prof. Hans Przibram and Prof. Wilhelm Figdor. The Institute founded by these biologists later became an important centre for research into the physiology of plants and animals. After the First World War the laboratory was presented to the Academy of Sciences in Vienna, Portheim being director of the department of botany. The Institute was destroyed during the Second World War.

When Austria fell under Nazi domination, Portheim's botanical career in that country came to an untimely end, for he was forced to leave the institute which he himself had helped to found, and he fled from the country. Arriving in Great Britain in December 1938 with a note of introduction from the famous Swiss botanist, Carl Schröter of Zurich, he was given hospitality at the Jodrell Laboratory at the Royal Botanic Gardens, Kew, by the late Sir Arthur W. Hill, who was then director of the Gardens. He continued to work at Kew until afflicted with the illness from which he died.

Although his work is not very familiar to British workers, Portheim published papers dealing with plant physiology and related subjects. During the First World War his investigations were concerned especially with the production of fats by some of the lower fungi. He also studied the influence of light on the growth of plants, and later became interested in the action of plant growth substances. The researches on heteroauxin which he started in Vienna were continued at Kew, where he also performed the remarkable achievement of keeping various members of the xerophytic Cactaceæ alive, and caused them to flower in jars of tap water during a period of about five years. He also did some experimental work on antibiotic substances. During his time at Kew he was severely handicapped by poor eyesight, which made it impossible for him to use a microscope. Nevertheless, the extreme care and patience with which he followed his experiments were most praiseworthy, while his attention to detail was such that not even the most trivial facts escaped his notice.

Portheim, who travelled extensively in Europe and also visited the United States, was a man of great personal charm and kindliness, while he was endowed with a keen sense of humour. His extreme modesty and retiring disposition undoubtedly led many to under-estimate his wide knowledge of the physiology of plants. Those who were privileged to know him more intimately found him to have a wide and cultured outlook and to be a firm friend. He will for long be remembered by all who worked at the Jodrell Laboratory while he was there. He leaves a widow and married daughter. C. R. METCALFE

Prof. J. Velíšek

By the death of Dr. Joseph Velíšek, professor of physical chemistry at Brno Technical College, on February 2, Czechoslovakia is deprived of another comparatively young and energetic teacher and investigator. Velíšek was only fifty years of age and had not long succeeded Prof. Baborovský, whose assistant he had been for many years. In 1922–23 Velíšek, under Jorissen at Leyden in Holland, investigated the influence of the vapours of non-inflammable liquids on the explosion limits of methane–air mixtures. His other scientific work included a special study of the hydration of lithium ions, the electro-osmosis of alkali chlorides and other salts through porcelain diaphragms, the use of calcium for electrodes and an examination of the 'turbulent' or 'hydraulic' flow of liquids. Prof. Velíšek was a keen amateur cinematographer. J. G. F. DRUCE

WE regret to announce the following deaths:

Mr. B. Hilton Barrett, lecturer in geology in the University of Glasgow for nearly thirty years, on June 9.

Dr. D. E. Lea, reader in radiobiology in the University of Cambridge, on June 16, aged thirty-seven.

Prof. Philip W. Schutz, professor of chemical engineering in the University of California, known for his work in chemical engineering thermodynamics and dielectric heating, on March 7, aged thirty-eight.

Prof. A. F. Bernard Shaw, professor of pathology in the University of Durham, and during 1933–38 professor of pathology in the Egyptian University, Cairo, on June 3, aged fifty-eight.

NEWS and VIEWS

King's Birthday Honours List

The following names of scientific men and others associated with scientific work appear in the King's Birthday Honours List:

Baron: Sir Roy Lister Robinson, chairman of the Forestry Commission.

C.H.: J. W. Robertson Scott, author, founder and until recently editor of *The Countryman*.

D.B.E.: Miss Caroline Haslett, for services to the Board of Trade and Ministry of Labour.

Knights: Dr. William Norwood East, for services to the study of criminal psychology; R. R. Enfield, chief economic adviser, Ministry of Agriculture and Fisheries; Prof. D. D. Henderson, professor of psychiatry, University of Edinburgh; Prof. E. L. Kennaway, lately director of the Chester Beatty Research Institute, Royal Cancer Hospital, London; Dr. A. McCance, deputy chairman and joint managing director of Messrs. Colville's, Ltd., Glasgow, a member of the Advisory Council to the Committee of Privy Council for Scientific and Industrial Research; Prof. A. Plant, Sir Ernest Cassel professor of commerce with special relation to business administration at the London School of Economics and Political Science, for services to Government Departments.

C.B.: Dr. E. T. Paris, principal director of scientific research (defence), Ministry of Supply.

C.S.I.: J. P. Mills, adviser to the Governor for Tribal Areas and States, Shillong, Assam; V. K. Maitland, chief conservator of forests, Central Provinces and Berar.

C.M.G.: R. W. Thornton, agricultural adviser to the High Commissioner for Basuto, the Bechuanaland Protectorate and Swaziland, and director of the Native Land Settlement Department, Swaziland; R. Watson, director of agriculture, Burma.

C.I.E.: W. G. Dyson, chief conservator of forests, Madras.

C.B.E.: J. E. C. Bailey, managing director of Baird and Tatlock, Ltd.; G. L. Brown, of the National Institute for Medical Research, London, for services to medical research in the Royal Navy; O. F. Brown, assistant secretary, Department of Scientific and Industrial Research; N. S. Clouston, lately commissioner of lands and director of surveys, Nigeria; R. R. Glanville, director of agriculture, Sierra Leone; J. H. Gunlake, lately assistant statistical adviser, Ministry of Transport; Dr. J. A. Gunn, director of the Nuffield Institute for Medical Research, University of Oxford, and chairman of the British Pharmacopœia Revision Committee; H. L. Kirke, head of the Research Department, B.B.C.; Prof. T. D. J. Leech, dean of the Faculty of Engineering, Auckland University College; J. R. Lumsden, chairman of directors, Highland and Agricultural Society of Scotland; Prof. J. A. Prescott, director of the Waite Agricultural Research Institute and chief of the Division of Soils, Council for Scientific and Industrial Research, Australia; F. A. Secrett, technical adviser on vegetable production, Ministry of Agriculture; J. M. Wordie, for services to exploration in the Antarctic.

Jacksonian Professorship at Cambridge: Dr. O. R. Frisch, O.B.E.

Dr. O. R. Frisch has been appointed to the Jacksonian professorship of natural philosophy in the University of Cambridge in succession to Dr. J. D. Cockcroft. Dr. Frisch was born in 1904 in Vienna and was educated at the University of Vienna during 1922–26. He worked on photometry and interferometry at the Physikalisch Technische Reichsanstalt in Berlin between 1927 and 1930. He then took up work with Prof. Otto Stern on experiments with molecular beams. With Stern he determined by this method the magnetic moment of the proton and studied the diffraction of helium atomic beams by crystal faces. During 1933–34 he worked for a year with Prof. P. M. S. Blackett, and then for five years with Prof. Niels Bohr at Copenhagen. With L. Meitner he was the first to demonstrate by experiment in an ion chamber the physical nature of nuclear fission. He went to Birmingham in 1939. In the spring of 1940, with Prof. R. E. Peierls, he worked out the possibility of producing an atomic bomb by the fission of U235, and thereafter worked on this project for the British Government. In 1943 he proceeded to Los Alamos as part of the British team working with the U.S. Atomic Energy Project, and carried out important experimental work on the atomic bomb. For this work he was awarded the O.B.E. in 1946 and the Medal of Freedom with Bronze Palm (U.S.) in May 1947. Dr. Frisch has been deputy chief scientific officer in charge of nuclear physics at Harwell since 1946. By his election to the Jacksonian professorship, the Cambridge school of nuclear physics is assured of distinguished leadership.

Physics at St. Andrews: Prof. J. F. Allen

The vacancy in the chair of natural philosophy in the United College, St. Andrews, due to the acceptance last year by Prof. J. T. Randall of the Wheatstone chair of experimental physics at King's College, London, has now been filled by the election of Dr. J. F. Allen, of St. John's College, Cambridge, to the post. Dr. Allen is a graduate of the Universities of Manitoba, Toronto and Cambridge, and has been a research assistant in the Royal Society Mond Laboratory, Cambridge, where he conducted research on liquid helium and on magnetic cooling. During the war years he was engaged in work on behalf of the Ministry of Aircraft Production and the Ministry of Supply. It is anticipated that he will continue low-temperature research in a new laboratory to be built at St. Andrews.

Royal Aeronautical Society: Dr. H. Roxbee Cox

Dr. H. Roxbee Cox has been elected president of the Royal Aeronautical Society for 1947–48, and takes office on October 1, 1947. Dr. Roxbee Cox, who was born in 1902, obtained first-class honours in engineering and took an advanced course in aeronautics at the Imperial College of Science and Technology, London. In 1924 he joined the Royal Airship Works. Four years later he was awarded the R.38 Memorial Prize of the Society for his paper on "The External Loads on an Airship Structure". Following the Government decision to discontinue airship work, Dr. Roxbee Cox returned to the Royal Aircraft Establishment, renewing his work on wing flutter, aircraft structures and aerodynamics, and in 1936 became head of the Air Defence Department at the Establishment. In 1938 he was appointed chief technical officer to the Air Registration Board, and on the outbreak of war seconded as superintendent of scientific research at the Royal Aircraft Establishment. In 1940 he became deputy director of scientific research in the Air Ministry, paying special attention to jet propulsion gas turbines; at the Ministry of Aircraft Production as director of special projects he became closely associated with all British gas turbine work. In 1944 Dr. Roxbee Cox became chairman and managing director of Power Jets (Research and Development), Ltd., and when it became a Government establishment under the title of the National Gas Turbine Establishment he was appointed director. In 1940 he delivered the Wilbur Wright Memorial Lecture of the Royal Aeronautical Society, speaking on civil aviation, and in 1945 the Wright Brothers Memorial Lecture of the Institute of the Aeronautical Sciences on gas turbines. Last May he was honoured by the Universities of Brussels and Louvain and the Faculté Polytechnique de Hainaut at Mons. At Louvain Dr. Roxbee Cox was presented with the Memorial Medal of the University, and at Mons he was made an honorary member (of whom only five people have been so honoured) of the Association des Ingenieurs de la Faculté Polytechnique de Mons.

Emergency Committee of Atomic Scientists

"A NEW type of thinking is essential if man is to survive and move to higher levels." These words are quoted from a statement made last summer by Prof. Albert Einstein with which he designed to shock the world out of its complacency. Together with other prominent American men of science he expressed great concern at the use to which mankind would put atomic energy. He recognized that the problem, as Mr. Baruch has so wisely put it, is not one of physics but of ethics, and it is his belief that the only security and hope for mankind lies in a public educated to understand the simple facts concerning atomic energy and their implications for society, for an informed public will surely act for life and not for death.

A million dollars is needed for this great educational task. To collect this money, and to use it in an educational campaign to ensure that atomic energy will be used for the benefit of mankind and not for humanity's destruction, the Emergency Committee of Atomic Scientists, Incorporated, with headquarters at Princeton, New Jersey (Room 28, 90 Nassau Street), has been formed. The trustees are Albert Einstein (*chairman*), H. C. Urey (*vice-chairman*), H. A. Bethe, T. R. Hogness, P. M. Morse, L. Pauling, L. Szilard and V. F. Weisskopf. The Committee's programme, as outlined in communications recently received from Prof. Einstein, is to see that the following simple facts, which are accepted by all scientific workers, are given the widest possible publicity. They are: (1) that atomic bombs can now be made cheaply and in quantity, with future bombs likely to be even more powerful and destructive; (2) that there is no military defence against atomic bombs; (3) that other nations can discover for themselves the processes kept secret by the United States; (4) that preparedness against atomic warfare is futile and, if attempted, will ruin the structure of social order; (5) that if war does occur, atomic bombs will definitely be used, and will surely destroy our civilization; and (6) that international control of atomic energy and, ultimately, the elimination of war, is the only solution to the problem.

The Emergency Committee does not propose to make governmental policy, either at the national or international level, but intends to work through all appropriate educational organisations, including associations such as the Federation of American Scientists, into which, it will be recalled, most of the American organisations of scientific workers, which sprang into being spontaneously with the dropping of the atomic bomb on Hiroshima and the purpose of which was the study and promotion of atomic energy control, have since been united. The Federation, some time ago, set up a Committee for Foreign Correspondence (Box 615, Berkeley, California) to distribute literature on problems of atomic energy control throughout the world. With financial assistance recently received from the Einstein Emergency Committee, the Foreign Correspondence Committee has now been enabled to widen its activities very considerably. Letters, in a variety of languages, are being sent to scientific and social organisations, libraries, student groups, etc., and also to individuals in more than sixty different countries, in order to keep the public informed of developments in the United States; to develop an important medium for analysing mutual problems; to convince others of the sincerity of American men of science; and to create sufficient confidence, through friendly contact and understanding, to permit the operation of an international system of atomic control which is one of the keystones of the establishment of world peace.

Mutations Induced by Irradiation of the Substrate

W. S. STONE, O. Wyss and F. Haas (*Proc. U.S. Nat. Acad. Sci.*, **33**, 59; 1947) have discovered that mutations of *Staphylococcus aureus* may be induced by irradiating the medium with ultra-violet light before inoculation. Even a delay of 30 hours between irradiation and inoculation gave positive results. If the Fildes synthetic medium is irradiated, no growth takes place; this was later shown to result from toxic products of radiated glucose. Irradiation of the mineral salts of this medium gave no positive results, but irradiation of the vitamins and amino-acid fractions resulted in a marked increase of the mutation-rate. For example, penicillin-resistant mutants (in the irradiated series) ranged from six to a hundred times as many as in the controls; for resistance to streptomycin there was a similar increase of mutants. It was shown that these mutants were distinct and genetically controlled. Preliminary experiments indicate that it might be possible to induce an increase of a particular gene mutant without affecting others. The activation of the chemicals of the medium may be due to some mechanism involving a shift to a higher energy-level by the absorption of a quantum of energy during irradiation, or a definite change in the chemicals concerned. The substance created is called an 'activated mutator'.

Medical Libraries in the British Isles

MR. W. R. LE FANU's paper, "A List of Medical Libraries and Information Bureaux in the British Isles", in the *Journal of Documentation* of December 1946 is now available separately from the Association of Special Libraries and Information Bureaux (3*s*.). The list is based on a questionnaire issued by the Association in the autumn of 1944 to libraries known to possess medical collections and to hospitals, medical societies and medical institutions throughout the British Isles. Special libraries of pharmacy and veterinary medicine are included, but not those of anthropology or the biological sciences, except anatomy and physiology. Libraries and information bureaux are listed separately, the latter being institutions without libraries which have an active policy of gathering and disseminating information. The annotated lists are arranged alphabetically first for London, and then, separately, those outside London. A list of medical libraries holding periodicals registered in the World List and Union Catalogue is appended with an index of special collections and subjects.

Aerial Photographs for Scientific Purposes

From time to time aerial photographs are required for scientific purposes. Facilities for such photographs, required for non-commercial scientific purposes, may be provided by the Royal Air Force and Royal Navy, but such facilities are limited, and priority must, therefore, be allocated to the various requirements. The Advisory Committee on Airborne Research Facilities, a joint committee of the Royal Society and the Services, is to advise the Services on this matter. Requirements for photographs to be taken during 1948 should be forwarded to the Committee, at the Royal Society, Burlington House, London, W.1, before October 31, 1947; it will assist (*a*) if the envelope is marked 'Aerial Photographs'; (*b*) if grid references on the ordnance survey G.S.G.S. 1 in. series are quoted, alternatively exact latitude and longitude; and (*c*) if the scale required is stated. (It should be noted that cover is easier to provide in scales of 1/10,000 or 1/25,000.)

University of Birmingham: Appointments

The chair of production engineering established two years ago by a munificent gift from Messrs. Joseph Lucas, Ltd., has been filled by the appointment of Dr. T. U. Matthew, director of research of the Bedaux Company for Africa, Ltd. Dr. Matthew's exceptional ability, capacity for research, experience of the technical as well as the production and administrative sides of engineering, his wide interests and scholarly mind will enable him to fill the post with distinction and success. He had a brilliant career at King's College, London, and in post-graduate research at Cambridge. The chair of production engineering was established "to foster through research the full development of every aspect of Production Engineering and the education through special post-graduate courses of a supply of men who possess not only a sound grasp of the fundamentals of engineering but also a specialized knowledge of production methods and processes and the varied aspects of organisation and control".

The chair of zoology has been filled by the appointment of Mr. P. B. Medawar, lecturer in zoology in the University of Oxford and a fellow of Magdalen College.

Prof. V. G. Childe, professor of prehistoric European archæology in the University of London, has been appointed Mason Lecturer for 1947–48.

Commonwealth Fund Fellowships Awards

The Committee of Award of the Commonwealth Fund Fellowships has made the following appointments, among others, to fellowships tenable by British graduates in American universities for one year beginning September 1947: J. P. Bentley, Charing Cross Hospital Medical School and King's College, University of London, to Emory University, Atlanta, Georgia, in surgery; M. R. Bonham Carter, Balliol College, Oxford, to the University of Chicago, in political science; R. P. Brittain, University of Glasgow, to New York University College of Medicine, in forensic medicine; A. J. Y. Brown, University of Aberdeen, to the University of California, in economics; W. J. G. Cameron, College of Technology, Queen's University, Belfast, and Queen Mary College, University of London, to the University of Illinois, in engineering; F. J. Dyson, Trinity College, Cambridge, and Imperial College of Science and Technology, University of London, to Cornell University, in mathematics; F. H. Holmes, University of London, to Princeton University, in chemistry; Dr. James Innes, University of Edinburgh, to Washington University, St. Louis, in medicine; D. S. Jones, Corpus Christi College, Oxford, to the Massachusetts Institute of Technology, in mathematics; Dr. I. C. Jones, University of Liverpool, to Harvard University, in zoology; James Kenny, University of Glasgow, to Princeton University, in economics; Dr. G. A. Maw, University College, University of London, to Cornell University Medical School, in biochemistry; Bowman Scott, Imperial College of Science and Technology, University of London, to Harvard University School of Business Administration, in engineering; Alexander Slessor, University of Glasgow, to Harvard University Medical School, in medicine; Dr. Harry Stalker, University of Edinburgh, to Cornell University Medical School, in medicine.

The following have been appointed to fellowships tenable by candidates holding appointments in the Home Civil Service: T. F. Bird, Balliol College, Oxford, and London School of Economics, University of London, of the Ministry of Civil Aviation; C. E. Calveley, King's College, University of London, of the Post Office; J. A. R. Pimlott, Worcester College, Oxford, of the Lord President's Office; J. B. Williams, McGill University, and Trinity College, Cambridge, of the Colonial Office (fellowship awarded in 1939).

Announcements

At a Congregation at the University of Cambridge on June 12, eleven honorary degrees were conferred, including that of Sc.D. on: Prof. Linus C. Pauling, professor of chemistry in the Californian Institute of Technology; Sir Edward Mellanby, secretary of the Medical Research Council; Prof. C. T. R. Wilson, emeritus professor of natural philosophy in the University of Cambridge.

Prof. V. G. Childe, professor of prehistoric European archæology in the University of London, has been elected a member of the Royal Netherlands Academy of Sciences of Amsterdam (Section of Letters and Historical Sciences).

The Commissioners for the Exhibition of 1851 announce the award of senior studentships for 1947 to the following: On the recommendation of the University of Cambridge: J. S. Courtney-Pratt, for research in physics at the University of Cambridge. On the recommendation of the University of Oxford: D. H. Whiffen, for research in physical chemistry at the University of Oxford; E. M. Vaughan-Williams, for research in pharmacology at the University of Oxford. On the recommendation of the Imperial College of Science and Technology, London: Dr. K. D. Froome, for research in physics at the Imperial College of Science and Technology, London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Aromatization of *cyclo*Hexane Carboxylate in Liver Slices

A FEW examples of the occurrence of aromatization of alicyclic compounds in the animal body are known, and similar reactions have been suggested in the formation of sex hormones and possibly carcinogens from sterols and bile acids[1]. Hitherto, however, the reaction has not been demonstrated in isolated tissues. The ready conversion of *cyclo*hexane carboxylic acid to benzoic acid by the dog, man and rabbit[2] suggested investigation of this transformation as a preliminary to the fuller study of aromatization in tissues. Rabbits of about 2·8 kgm. weight were first fed or injected subcutaneously with doses of 1·6–2·6 gm. sodium *cyclo*hexane carboxylate, of which about 0·9 gm. was isolated in the form of hippuric acid from the urine passed in the next 24 hours, thus confirming the work of Bernhard[2], and showing an adequate rate of aromatization. A method was evolved[3] for the micro-estimation of benzoic or hippuric acid in presence of *cyclo*hexane carboxylic acid, depending on cold nitration to the *m*-nitro derivative, reduction of the latter to the amino-compound, and estimation by diazotization and coupling with N-(1-naphthyl)-ethylene diamine.

FORMATION OF BENZOIC ACID FROM *cyclo*HEXANE CARBOXYLATE BY RABBIT TISSUES

	Q^* benzoic acid
Liver slices, O$_2$, phosphate	0·19
" " " " + HCN	0·04
" " N$_2$ "	0·01
" " O$_2$ + CO$_2$, bicarb.	0·26
" " " " + HCN	0·06
Liver homogenate, O$_2$, phosphate	0·04
Kidney slices " "	0·09
Skeletal muscle " "	0·004
Blood	0·025
Testis	0·00
Spleen	0·00

Liver slices in phosp., O$_2$, *cyclo*hexane carboxylate molarity as follows:

	0·10	0·05	0·025	0·01	0·004	0·001 *M*
Q_{benzoic}	0·03	0·08	0·11	0·16	0·19	0·22

* To convert Q_{benzoic} to μgm. benzoic acid/mgm. dry wt. tissue per hour, multiply by 122/22·4 = 5·44.

The extent of formation of benzoic (or hippuric) acid from added *cyclo*hexane carboxylate by rabbit tissues is shown in the accompanying table. This aerobic oxidation occurs mainly in liver and kidney, is inhibited by anaerobic conditions or in presence of cyanide, and by homogenization of the tissue. Derivatives of *cyclo*hexane carboxylate (hexahydrohippuric acid and hexahydrobenzamide) are also aromatized. The reaction appears to be complex, involving intact cell structure and iron-containing respiratory enzymes. Attempts to prepare a dehydrogenase have as yet been unsuccessful.

It is remarkable that the formation of benzoic acid is strongly and increasingly inhibited by *cyclo*hexane carboxylate, even by concentrations (above 0·001 *M*) which scarcely affect the total respiration (see table). This fact makes isolation of the product more difficult, and for this purpose two 45-gm. portions of a sliced rabbit liver (total weight 95 gm.) were suspended in 450 ml. bicarbonate – Ringer solution (*a*) without, (*b*) with *cyclo*hexane carboxylate, 0·0012 *M*. After shaking for 3 hours at 38° in oxygen plus 5 per cent carbon dioxide, the solutions contained, by analysis, (*a*) 0·30 mgm., (*b*) 33·6 mgm. benzoic acid, that is, 55 per cent conversion of the added *cyclo*hexane carboxylate. The 60 per cent ethanol extracts were concentrated *in vacuo*, treated with tungstic acid, and extracted with ether for 20 hours. Recrystallization from water of the ether concentrate of (*b*) yielded 26 mgm. hippuric acid, identified by m.p., mixed m.p., and by m.p. and analysis of the *p*-nitrobenzyl ester. The source and function of the glycine used for conjugation are being examined.

The occurrence of aromatization in liver slices at a rate comparable with that in the intact animal is thus demonstrated, and other examples of this biologically important reaction are now being sought.

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Spectroscopic Estimation of Penicillin *G*

THE presence of a phenyl group enables penicillin *G* to be estimated in mixtures containing other penicillins of non-aromatic type. The spectra were photographed on Ilford Autofilter plates with a Hilger medium quartz spectrograph (*E* 498) using the continuous radiation from a hydrogen discharge lamp; an exposure of 30 sec. was needed with a slit width of approximately 0·05 mm. Under these conditions, phenyl absorption bands at 2685, 2645, 2585 and 2525 A. are observed with a solution of sodium penicillin *G* in a mixture (1 : 30) of water and ethanol having a concentration of 15 mgm./ml. at a path-length of 1·5 mm.

To compare the penicillin *G* contents of different samples of penicillin, the method of matching developed by Dr. W. C. Price[1] is used. The spectrum of the sample under investigation is photographed several times on a plate, using a series of path-lengths, which are varied by means of a Hilger micrometer cell or a wedge cell. Alongside each exposure is recorded the spectrum of a standard penicillin solution, using the same path-length each time. The path-length at which the spectrum of the unknown solution matches that of the standard is estimated by eye, interpolating between spectra when necessary. The relative concentrations of the two solutions are given by the inverse ratio of the path-lengths.

As an alternative to penicillin *G*, an alcoholic solution of phenyl acetamide (9 mgm./ml. at 1 mm. path-length) can be used as a sub-standard. Its spectrum is not identical with that of penicillin *G*, since the unspecific absorption of the penicillin molecule overlies some of the phenyl absorption bands, but matching is possible at 2685 A. and 2645 A. In penicillin *G*, these bands are displaced slightly (less than 3 A.) to shorter wave-lengths, and the displacement increases as more water is added to the solvent until, in water alone, it is about 12 A. and the bands are then very diffuse. The molar extinction coefficients of a reputedly pure sample of penicillin *G* and of phenyl acetamide were found to be the same at the matching wave-lengths. Recently, however, samples of sodium penicillin *G* have been prepared here that have an apparent purity of 104 per cent when compared in this way, and, clearly, the real penicillin *G* content of a sample cannot be determined until the spectrum of phenyl acetamide has been compared with that of pure sodium penicillin *G*. In the meantime, figures can be obtained which are in error only to the extent that the standard penicillin is impure.

If all the absorption at 2685 and 2645 A. were due only to penicillin *G*, a spectrophotometer could be used instead of matching. Unfortunately, in all but very pure samples of penicillin, the spectrum shows, in addition to the phenyl bands, a continuous absorption due to impurities, so that estimates from optical densities would be high. In the analysis of hydrocarbons, however, it has been found that, provided the additional unspecific absorption is not too strong, the pattern of a spectrum is not affected and can be used for matching. Similarly, we have found that the spectra of pale yellow samples of penicillin which give definite greying of the photographs can be matched against the spectrum of phenyl acetamide. The estimated error of the method is ± 2 per cent when the unspecific absorption is small; when it is large, matching is more difficult and results tend to be high.

With very yellow samples of penicillin, the method fails. In such instances, the samples can be oxidized with potassium permanganate solution at 100° C., the resulting suspension cleared with sulphur dioxide and an aliquot portion diluted with four times its volume of ethanol, filtered and matched as described above against a standard made by dissolving benzoic acid in ethanol and diluting with a quarter the volume of water. It was established by treating the purest available specimen that the oxidation of penicillin *G* to benzoic acid is quantitative. The presence of ethanol is essential, as the bands at 2810 and 2730 A., used for matching, do not appear in aqueous solution.

It should be emphasized that both these methods estimate all phenyl groups, including any that are present in deactivated products or impurities. With fairly pure samples, this does not appear to introduce serious errors; but with cruder preparations, results are correspondingly less reliable.

We are indebted to Dr. R. H. Hall for carrying out the oxidations, and to the directors of the Distillers Co., Ltd., for permission to publish this work.

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[1] W. C. Price, private communication.

Antibiotic Agents in the Substrates from Cultures of the Genus *Marasmius*

DURING current investigations into the production of antibiotic substances by Hymenomycetes, it was found that certain species of the genus *Marasmius* had a marked inhibiting effect upon growth of *Staphylococcus*.

In testing for antibiotic properties, the fungi were grown as surface felts on stationary shallow layers in Erlenmeyer flasks of 100 ml. capacity. The culture vessels used were made of special resistance glass; it had been found that the minute amounts of inorganic elements entering the nutrient solution from chemically resistant glassware of less satisfactory quality on sterilization in the autoclave were able to cause serious irregularities in the formation of antibacterial agents[1]. The synthetic nutrient media employed in the qualitative tests and in preliminary attempts to increase the yields of antibiotic substance contained, besides the usual mineral salts, glucose as the source of carbon and energy, and ammonium nitrate, ammonium chloride, or ammonium tartrate as the source of nitrogen. The media were supplemented with thiamin (1γ per 25 ml.), and, in some cases, with biotin ($0{\cdot}05\,\gamma$ per 25 ml.); these growth factors, added singly or together, being indispensable for normal growth of the fungus species tested[2]. The vitamin preparations used were thiamin hydrochloride Merck (Darmstadt) and biotin Merck (Rahway, N.J.). In some culture series the media contained small quantities of zinc, calcium and manganese added from dilute stock solutions of sulphates or chlorides, these minor elements being essential for, or promoting highly, the growth of species of *Marasmius*[2]. In other culture series the basal media were supplemented with 'Vitrum' malt extract or water extracts of aspen litter, the latter material containing organic and inorganic substances effective as growth-stimulating agents upon soil fungi of different biological groups[2-5]. The culture media were buffered to the respective optimum *p*H values by the addition of hydrochloric acid and solutions containing mixtures of mono- and dihydrogen phosphates. The nutrient solutions were sterilized by heating in the autoclave for 15 min. at a temperature of 120° C. or by passing through a Seitz filter. Each culture flask contained 25 ml. of the respective substrates.

The contents of the flasks were inoculated with square bits cut out from colonies of the fungi grown in Petri dishes on ordinary malt agar or on agar media made up with synthetic nutrient solution and malt extract. The area of each piece of inoculum was about 4 sq. mm. The cultures were incubated in the dark at a temperature of 25° C., great care being taken to keep the small pieces of inoculum floating on the surface of the substrate.

In order to gain information about possible relationships between growth of mycelium and formation of antibiotic substance, cultures of the different series were harvested at intervals of one or a few days, the fungal mats being weighed after thorough washing in distilled water and drying for 24 hr. at 100–102° C., and the substrates being tested for antibacterial activity against *Staphylococcus aureus* No. 266 by means of the cylinder plate method[1,6]. In addition, the hydrogen ion concentration of the substrates was determined electrometrically at all points of observation.

Both *Marasmius graminum* (Lib.) Berk. and Br. ap. Berk. and *M. ramealis* (Bull. ex Fr.) Fr. were found to be highly active producers of antibacterial agents on all the media tested. However, the formation of substances effective against *Staphylococcus* starts at different times on the different media. The duration and maximum level of antibiotic activity also vary considerably with composition of the medium. *M. foetidus* (Sow. ex Fr.) Fr. and *M. scorodonius* (Fr.) Fr. proved highly active against *Staphylococcus*. *M. alliaceus* (Jacq. ex Fr.) Fr., *M. androsaceus* (L. ex Fr.) Fr. and *M. rotula* (Scop. ex Fr.) Fr. were practically inactive under the conditions of the assay method used.

A more detailed account of the results of this investigation will be published in due course in Swedish journals of botany.

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Use of Potassium in the Assay of Curare

Now that tubocurarine, one of the curare alkaloids, is gaining importance in medicine, it is important that this compound and other curare-like substances should be biologically standardized. A suitable method has been described by Chou[1], utilizing the rat's phrenic nerve-diaphragm preparation of Bulbring[2]; but we have been unable to obtain consistent results with this technique. By using temperatures lower than usual for mammalian tissue work (namely, room temperature, about 20° C.), we have obtained satisfactory results. The preparation lasts for a much longer period of time, shows little sign of fatigue after eight hours, and contractions are more regular. Larger doses of tubocurarine are needed than those used at 37° C., and a reduction in contraction of approximately 50 per cent is obtained with 0·15 mgm.

The difficulty with this technique is that the preparation requires a long time for complete recovery (more than 30 min.); but this has been overcome by the addition of small amounts of potassium ions to the bath during recovery phase, after the curare action has been shown for 3–5 min., according to the preparation. The anti-curare action of potassium is well known. When recovery is complete, the potassium is washed out and the next dose of curare-like substance is added (a total of 6–10 min. after the last dose). Potassium chloride itself exerts a stimulating action in this preparation in small doses (20–30 mgm.), whereas in larger doses (80–100 mgm.) the depressant effect predominates. These quantities refer to an isolated organ bath of 75 ml. capacity.

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Leukotaxine and Histamine

Inflammatory exudates contain a polypeptide, leukotaxine, which has, among other properties, that of inducing increased capillary permeability on intracutaneous injection[1,2,3]. Other observations suggest that histamine may play a fundamental part in wheal formation of allergic and non-allergic origin[4–9]. It has therefore been suggested that the active factor in inflammatory exudates is really histamine and not leukotaxine, or that leukotaxine, if it exists, induces an increased permeability of the capillaries only through the mediation of histamine[8].

That leukotaxine is not histamine is suggested by the observations[1,2] that: (1) leukotaxine does not cause contraction of the isolated guinea pig ileum; (2) histamine is not chemotactic for leucocytes, but leukotaxine is; (3) intravenous injection of leukotaxine does not lower the blood pressure of the cat.

Moreover, crude preparations of leukotaxine, prepared by the method of Cullumbine and Rydon[2], when extracted for histamine (Barsoum and Gaddum's method[10]) and assayed on the isolated guinea pig ileum, yield insignificant quantities of histamine; for example, 6 mgm. (550 'units') of crude leukotaxine contained less than 2 μgm. of histamine.

We have used the anti-histamine substance 'Neoantergan', or 2786 R.P., which prevents or diminishes the action of histamine in increasing capillary permeability[11,12] in further studies on the mode of action of leukotaxine and the production of œdema following cutaneous burning.

We have observed that rabbits burned under nembutal anæsthesia, by exposing their depilated abdomens for 90 sec. to a glass vessel containing water at 70° C., develop extensive subcutaneous œdema of the abdominal wall within two to four hours of burning. The subcutaneous injection of 'Neoantergan' in a 10 mgm./kgm. dose (half the subcutaneous dose of this drug required to produce toxic symptoms in the rabbit) 30 min. before, or immediately after, or one hour or two hours after burning did not apparently affect the rate of development of the œdema or the degree of œdema produced by the burning.

Each burned area of skin yielded 30,000–60,000 'units' of leukotaxine. The intracutaneous injection of 60,000 'units' of leukotaxine into the abdominal wall of normal rabbits or rabbits medicated with 'Neoantergan' (10 mgm./kgm.) produced an œdema comparable to that induced by the burning.

If 1·25 c.c./kgm. of a 5 per cent solution of Pontamine Blue in 0·6 per cent saline is injected intravenously into a rabbit, and then a solution (0·2 c.c.) of leukotaxine or of histamine is injected intracutaneously into the depilated abdominal wall of the rabbit, blue areas rapidly develop at the sites of the cutaneous injections. 'Neoantergan' administered: (1) subcutaneously in a 10 mgm./kgm. dose and 30 min. before the test agents (0·2 c.c. of solutions containing 0·1 mgm. crude leukotaxine/c.c. or 0·1 mgm. histamine/c.c. respectively); or (2) intracutaneously (0·2 c.c. of a solution containing 40 mgm./c.c.) at the sites of injection of the test agents and immediately after the test agents; or (3) intracutaneously in a solution containing 40 mgm. 'Neoantergan'/c.c. and 0·1 mgm. crude leukotaxine/c.c. or 0·1 mgm. histamine/c.c., did not prevent the development or diminish the intensity of the blue staining at the sites of injection of the leukotaxine solution, but did completely prevent the blue staining at the sites of the histamine injection.

These observations suggest that the local liberation of histamine is not necessary for the production of subcutaneous œdema after cutaneous burning in the rabbit, and that leukotaxine does not induce an increased capillary permeability through the mediation of histamine. But the evidence is not conclusive, since the doses of 'Neoantergan' used, although large, may have been inadequate to deal with the amount of histamine that may have been liberated locally by the leukotaxine preparations. Higher concentrations of 'Neoantergan' cannot be used locally, since this drug itself, on intracutaneous injection in high concentration, produces a positive blue reaction and so may mask the leukotaxine reaction. This local irritant action of 'Neoantergan' suggests that histamine cannot take an intermediary role in the production of increased capillary permeability during the inflammatory reaction.

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Serum Bilirubin and the Van Den Bergh Reaction

THE problem of the nature of direct and indirect bilirubin remains obscure, in spite of many attempts to explain the phenomenon of the two types of reaction. Some authors[1] still believe that direct bilirubin is free, and that indirect bilirubin is combined with serum protein, and alcohol converts one to the other, as does the liver, by an uncoupling action. However, this view seems no longer tenable since much evidence is available to show that both forms of bilirubin are combined with serum albumin[2-4]. The dual reaction is ascribed to the different strength of attachment of the pigment to the protein[5,6].

In our experiments no evidence was obtained supporting this view. The burden of the investigation is as follows:

(1) Addition of the most active promoting substances was without effect upon the attachment to protein, as deduced by dialysis and ultrafiltration experiments. Caffeine was exceptional in causing fission, although its effect in the van den Bergh reaction is more delayed.

(2) The final product, azobilirubin, was found to be combined with serum protein in every case. It is clear, therefore, that the behaviour of bilirubin is not to be explained by its liberation from protein attachment.

(3) Enzyme digestion of serum containing bilirubin or artificial bilirubin-protein compounds (prepared from serum albumin, serum globulin, globin or casein) by means of papain or pancreatin under optimum conditions caused no change of reaction. The reaction was indirect in each case, before and also following enzyme digestion, suggesting that neither the type of protein (cf. ref. 6) nor its size is a critical factor in the rate of production of azobilirubin.

(4) In addition to those substances known to change indirect to direct reacting bilirubin (ethanol, acetic acid, acetone, caffeine), we have found that pyridine exhibits this action in low concentration (5 per cent in serum) without precipitating the serum proteins or diluting the final colour. The introduction of pyridine in the van den Bergh test for bilirubin would bring many advantages.

(5) In a comparative study of the promoting effect of several alcohols, methanol, ethanol, propanol and isopropanol were equally active, higher alcohols less active, and glycerol and ethylene glycol gave negative results.

(6) No specific factor able to facilitate the van den Bergh reaction with bilirubin could be demonstrated or separated from direct sera, nor does there appear to be an inhibitor in indirect serum. Examination was made both of native serum and also following enzyme digestion to detach adsorbed substances from the protein.

(7) It is apparent that differences in the type of reaction must be ascribed to the pigment itself. The possibility arises that indirect bilirubin may be an intermediate precursor of bilirubin in hæmoglobin breakdown, still attached to globin, the precipitation reactions of which simulate those of serum albumin. This supposition has received experimental support, because direct-reacting serum when mildly oxidized with 0·3 per cent hydrogen peroxide under controlled conditions exhibits the characteristic behaviour of indirect serum bilirubin with the van den Bergh reagent and alcohol or pyridine.

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Neutral Auxins

IN a previous paper[1], I have presented evidence that 3-indole acetaldehyde is a growth hormone in higher plants. Since this substance has not been prepared in the pure state, only indirect evidence that the auxin found is actually 3-indole acetaldehyde could be provided. Dr. K. A. Jensen, of the Chemical Laboratory, University of Copenhagen, has made a crude preparation of 3-indole acetaldehyde which I have tested. It proved to act in the same way as the neutral fraction of ether extracts of etiolated plants and as the crude preparations obtained by treatment of tryptophane with isatin or ninhydrin. The attempts to synthesize 3-indole acetaldehyde are being continued and will be reported elsewhere. In addition, an investigation on a series of other non-acid homologues of acid auxins has been started. Some of the results of this work are given below.

The accompanying table gives the relative activity of the compounds tested, based on the concentrations required for 5° curvature in the *Avena* test as carried out in this Laboratory, using soil-grown test plants. The values for 3-indole acetaldehyde are based on determinations obtained after the aldehyde had been converted to 3-indole acetic acid by treatment with soil[1]. The values have been corrected for a destruction of 50 per cent which is also caused by the soil in the procedure used (destruction was determined in experiments with the pure acid). These

Substance tested	Concentration required for 5°* curvature in the *Avena* test Mgm./l.	Relative activity	Maximum angle	
			Mgm./l.	Degrees*
3-Indole acetic acid	0·026	100	0·15	58
3-Indole acetaldehyde	0·125?	20 ?	0·20	20–50
3-Indole ethyl alcohol	250	0·01	450	8·5
α-Naphthalene acetic acid	0·09	29	2·7	30
α-Naphthalene acetaldehyde	48	0·05	120	14
Phenyl acetic acid	2500	0·001	10^4	8
Phenyl acetaldehyde	—	7×10^{-5}	3×10^4	6

* 5° curvature corresponds to a *d*-value of 0·10 (*d* is the difference in length between the inner and outer side of the curved coleoptile, measured in mm.).

values are, of course, uncertain; the relative activity may be between 10 and 40. 3-Indole ethyl alcohol (tryptophol) and α-naphthalene acetaldehyde were prepared by Dr. K. A. Jensen. These substances, as well as phenyl acetaldehyde, were freed from possible traces of acid substances by shaking ethereal solutions with alkaline water immediately before the test; phenyl acetaldehyde was redistilled before shaking. As 5° curvature is near the maximum angle produced by the latter substance, its relative activity was calculated on the basis of 3° curvature. In the table are also shown the maximum angles for the compounds tested and the concentration needed for maximum curvature.

Other workers (using water-cultured test plants) found the relative activities of alpha-naphthalene acetic acid and phenylacetic acid to be 2·5 and 0·02, respectively (compare Veldstra's list[2]). These values do not agree with those given here, obtained on soil-grown plants. This discrepancy may be due to the different methods of cultivating the test plants.

3-Indole acetaldehyde could be oxidized to 3-indoleacetic acid by treatment either with raw milk, with a purified Schardinger enzyme preparation (aldehydrase) or with soil. By soil treatment the activity of the aldehyde preparations was increased about 2·5 times. Soil treatment of indole ethyl alcohol and of alpha-naphthalene acetaldehyde preparations increased their activities by 100 and 20 times, respectively, indicating that these compounds are also oxidized by the soil, with the formation of the much more active acids.

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March 17.

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[1] Larsen, Poul, thesis, Copenhagen. *Dansk. Bot. Arkiv.*, **11**, No. 9, 132 (1944).

[2] Veldstra, H., *Enzymol.*, **11**, 97 (1944).

Molecular Weight of Melanin

A METHOD of obtaining protein macro-molecules in crystalline form by the use of heparin has been described by Cohen[1]. As melanin is generally believed to have a high molecular weight, an attempt has been made to crystallize it by Cohen's method, using ethylene chlorhydrin as solvent. Heparin is not soluble to any appreciable extent in pure ethylene chlorhydrin; but both it and melanin are soluble in a mixture of equal parts of water and ethylene chlorhydrin. 'Dopa' and *Sepia* melanin have been used, with concentrations of heparin of 1, 2, 5, and 10 per cent, with and without addition of electrolyte (sodium chloride), at temperatures varying from –20° to 20° C. The attempt has failed completely, no precipitate being observed under any conditions even after standing for seven days.

It was observed by Cohen that although a number of highly complex proteins were precipitated by this method, those of comparatively low molecular weight, for example, gelatin, edestin and pepsin, did not respond, even with concentrations of heparin up to 10 per cent. This suggests, though by no means proves, that the molecule of melanin may not be so large as has been supposed. Further work at present in progress tends to support this view.

The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

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March 16.

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[1] Cohen, S. S., *J. Biol. Chem.*, **144**, 353 (1942).

Free Radicals from Benzyl Hyponitrite

WE have recently prepared benzyl hyponitrite by the method of Partington and Shah[1], and have found that it readily catalyses the polymerization of methyl methacrylate at room temperatures. At 30° C. the rate of polymerization of methyl methacrylate initiated with benzyl hyponitrite is approximately thirty times as fast as the rate observed with an equal amount of benzoyl peroxide.

The polymerization of this monomer is known to be initiated by free radicals, and the benzyl hyponitrite must therefore produce free radicals by decomposition. By analogy with other compounds containing the —N=N— group which are sources of free radicals, it is probable that benzyl hyponitrite decomposes into two benzoxy radicals $C_6H_5CH_2O$— with the elimination of nitrogen. The formation of benzaldehyde and benzyl alcohol in presence of water reported by Partington and Shah could then be due to disproportionation of these benzoxy radicals.

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[1] Partington and Shah, *J. Chem. Soc.*, 2589 (1932).

Addition of Dinitro Compounds to D.D.T. to Prevent Outbreak of Spider Mites

IT is frequently observed that the use of sprays containing D.D.T. on fruit trees leads to a severe outbreak of Tetranychid mites or red spiders. In the United States, for example, *Tetranychus pacificus* McG., *Paratetranychus pilosus* C. & F. and *P. citri* McG. have all been found to increase very considerably after D.D.T.-spraying has killed the predaceous insects which normally keep them under control. Research workers who have obtained excellent control of codling moth (*Cydia pomonella* L.) or other pests with D.D.T. have felt unable to recommend its general use owing to the risk of producing a severe mite infestation. It may therefore be of interest to record a method by which this difficulty was overcome by the addition of dinitro-*ortho*-*cyclo*hexylphenol to the spray. The successful use of this material in the United States has been recorded, but does not appear to be widely known even there; and it has never previously been tested on *Bryobia* mite, the prevailing 'red spider' of South African and Australian fruit crops.

Spraying trials against codling moth were carried out in South Africa during the 1946–47 season at Elgin, Cape Province, in collaboration with the Western Province Fruit Research Station, Stellenbosch. Two D.D.T. preparations were used, a xylene emulsion and a dispersible powder, both diluted to give 0·1 per cent actual D.D.T. The remainder of the orchard received the standard treatment with a proprietary nicotine–bentonite preparation. By the end of December, after five sprays, a heavy outbreak of *Bryobia prœtiosa* Koch was evident on the D.D.T.-sprayed trees, but there were very few on those which received nicotine. After this time, owing to shortage of supplies, it was unfortunately necessary to use a proprietary fixed nicotine containing 0·05 per cent D.D.T., and the red spiders then began to increase also on these plots. On January 8 and 19 and February 9, 1947, half of each plot was sprayed with D.D.T. containing dinitro-*ortho*-*cyclo*hexylphenol in the form of its di*cyclo*hexylamine salt at 0·00625 per cent. A sample of the red spider population taken on February 17 gave the result shown in the following table, in which the figures for the active and 'resting' stages are combined.

Summer spray schedule	Total spiders per 16 leaves	
	Without dinitro compound	With dinitro compound in 3 sprays
D.D.T. (0·1%) emulsion, 9 sprays	644	32
D.D.T. (0·1%) dispersible powder, 9 sprays	768	26
Fixed nicotine (0·05%) in first 4 sprays and fixed nicotine (0·025%) + 0·05% D.D.T. in last 5 sprays	246	175

The protection against *Bryobia* mite afforded by the addition of dinitro-*ortho*-*cyclo*hexylphenol, used even after an outbreak had started, is evident from the above figures. The dinitro compound is not so effective when used with fixed nicotine, presumably owing to formation of a nicotine salt of dinitro-*ortho*-*cyclo*hexylphenol, which is less toxic than the di*cyclo*hexylamine salt, or to adsorption on the bentonite. This point is being further investigated.

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Autoxidation of Olefins: Formation of Unsaturated Alcohols from Olefins by the Action of Organic Peracids

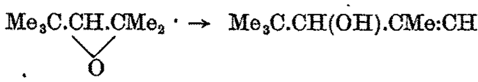
IT was reported in a previous communication[1] that peracetic acid reacts with α- and β-di*iso*butylenes to give an unsaturated alcohol and high-boiling material of the molecular formula $C_{16}H_{32}O_3$ in addition to the expected glycol. Thus β-di*iso*butylene (I) yields the unsaturated alcohol (II) with alteration in the position of the double bond; α-di*iso*butylene (III) gives rise to the two unsaturated alcohols (IV) and (V).

$Me_3C.CH{:}CMe_2$ (I) $Me_3C.CH(OH).CMe{:}CH_2$ (II)

$Me_3C.CH.CMe{:}CH_2$ (III) $Me_3C{:}CH{:}CMe.CH_2(OH)$ (IV)
$Me_3C{:}CH_2.C(CH_2OH){:}CH_2$ (V)

It is now found that the formation of these unsaturated alcohols does not depend on substitution of the olefin, but on the isomerization of the epoxide which is an intermediate in the reaction.

Thus 2 : 4 : 4-trimethylpentan-2 : 3-epoxide (VI) on treatment with acetic acid containing a trace of sulphuric acid gives 2 : 4 : 4-trimethylpenten-1-ol-3 (VII), the mono-acetate of 2 : 4 : 4-trimethylpentan-2 : 3-diol, and a high boiling liquid which is provisionally formulated as a tetramethyl di-*tert*.-butyl 1 : 4-dioxane. These are the main products of the reaction; but there is also formed an aldehyde which is presumably 2 : 2 : 3 : 3-tetramethylbutanal. The yield of unsaturated alcohol in this reaction is approximately equal to that of the glycol; that of the dioxane is rather less, while the aldehyde is only a minor product.



$Me_3C.CH.CMe_2$ (with O bridging, VI) → $Me_3C.CH(OH).CMe{:}CH_2$

(VI) (VII)

A change in the position of the double bond during the peroxidation of an olefin by molecular oxygen is said to occur[2-4], and it has been suggested[5,6] that the preliminary phase is the formation of a moloxide by saturation of the double bond by a molecule of oxygen. The hydroperoxide would then result by opening of the moloxide ring and change in position of the double bond.

The work described above now provides experimental support for this hypothesis by the demonstration that a similar system, namely, the epoxide ring, can behave in the manner postulated. Further, it suggests, if the analogy between the two types of oxygenated ring systems may be maintained, that the opening of the ring system may be accompanied by the formation of bimolecular oxygenated compounds and also carbonyl compounds. Such compounds are always formed during the peroxidation of olefins[7,8], and it might well be that they are formed at the same time as the hydroperoxide.

Further evidence that the double bond of the olefin is the initial point of attack during peroxidation is the presence of an epoxide among the products of air oxidation[8,9]. Although it is possible to explain these observations by assuming that the epoxide arises by a reaction of the hydroperoxide with the olefin, it may equally well arise from the moloxide by a side reaction.

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[1] Byers and Hickinbottom, *Nature*, **158**, 341 (1946).
[2] Farmer and Sutton, *J. Chem. Soc.*, 119 (1943).
[3] Bergström, *Nature*, **156**, 717 (1945).
[4] Gunstone and Hilditch, *J. Chem. Soc.*, 1024 (1946).
[5] Farmer, *Trans. Farad. Soc.*, **42**, 235 (1946).
[6] Bolland and Gee, *Trans. Farad. Soc.*, **42**, 247 (1946).
[7] Stephens, *J. Amer. Chem. Soc.*, **50**, 568 (1928).
[8] Farmer and Sandraligam, *J. Chem. Soc.*, 121 (1942).
[9] Pacquot, *Bull. Soc. Chem.*, v, **8**, 695 (1941).

The Meson Spectrum Near Sea-Level

L. Jánossy and J. C. Wilson determined, some time ago[1], from a comparison of theoretical and experimental spectra at sea-level the exponent γ in the production spectrum of mesons $dN = \text{const. } p^{-\gamma}dp$; they find a value $\gamma = 3\cdot3$. As this value differs appreciably from the ordinarily accepted one, we have thought it worth while to check the above result by a more accurate method, taking account of the variable energy-loss of mesons through the atmosphere.

The basis of our computation is a formula for the vertical meson spectrum at sea-level derived by M. E. Rose[2] with the hypothesis of an initial $\varepsilon^{-\gamma}$ spectrum. This formula is

$$f(\varepsilon,t_s)d\varepsilon = C_0 \frac{B(\varepsilon')}{B(\varepsilon)} \varepsilon'^{-\gamma} \exp{(-\alpha D)}d\varepsilon,$$

where ε' is the energy at the production level of a meson having energy ε at sea-level; $B(\varepsilon)$ is the energy loss $-\frac{d\varepsilon}{dt}$ (t in gm./cm.^{2}); $\alpha = \frac{t_s}{\rho_s c \tau_0}$ (with t_s height of the atmosphere in gm./cm.^{2}, ρ_s air density at sea-level, $c = 3 \times 10^{10}$ cm./sec., and τ_0 mean life of the meson at rest); D is the integral $\int_{R_s}^{R_0} \frac{dR}{tp(R)}$, with R_0, R_s residual ranges (in gm./cm.^{2}), of mesons of energies ε' and ε (p momentum of the meson).

Rose's expression is quite different from that given by Euler and Heisenberg[3], owing to a different treatment of the absorption of mesons. However, it is easily verified that it satisfies the following differential equation:

$$\frac{\partial f}{\partial t} = B(\varepsilon)\frac{\partial f}{\partial \varepsilon} + f\frac{dB(\varepsilon)}{d\varepsilon} - f\frac{\alpha}{pt},$$

where $f(\varepsilon,t)$ is the differential energy spectrum at level t. This equation is the generalization of that of Euler and Heisenberg to the case of variable energy loss (and energy- instead of momentum-distribution).

Assuming an initial spectrum $p^{-\gamma}$, instead of $\varepsilon^{-\gamma}$, Rose's formula becomes

$$dN = C\frac{B(\varepsilon')}{B(\varepsilon)}(\varepsilon'^2 + 2\varepsilon')^{-(\gamma+1)/2}(\varepsilon + 1)\exp{(-\alpha D)}\,d\varepsilon.$$

(Energy unit $= \mu c^2 = \sim 10^8$ eV.)

We have used this formula. It contains three parameters to be adjusted from experimental data: the normalization factor C, the exponent γ and α (corresponding to the mean life τ_0 of the meson). Each of these parameters appears linearly in the expression of log $dN/d\varepsilon$, making it relatively easy to apply a least squares method to log $dN/d\varepsilon$ and determine the parameters simultaneously.

The experimental data were those used by Jánossy and Wilson, namely, those of Blackett, Jones and Wilson, with the exclusion of the doubtful value near $\varepsilon = 1\cdot5 \times 10^{10}$ eV. To avoid giving a greater statistical weight to the high-energy region owing to the greater number of determinations, we averaged the experimental data, taking as experimental spectrum (normalized to maximum value 1):

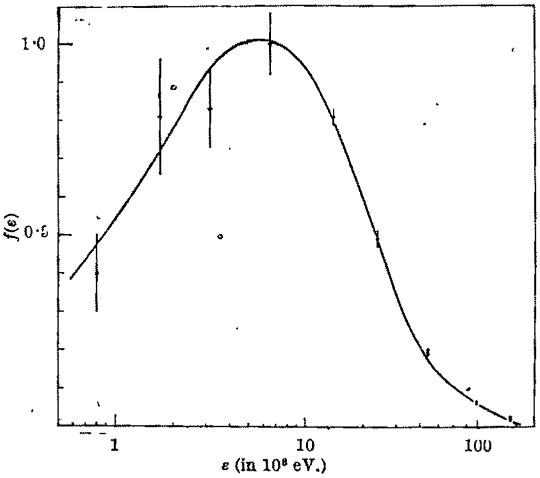
ε	$\frac{dN}{d\varepsilon}$	ε	$\frac{dN}{d\varepsilon}$
0·8	0·40	14·03	0·81
1·69	0·81	24·02	0·49
3·13	0·83	44·01	0·195
6·57	1·00	79·0	0·061

Application of the least squares method gives

$$\gamma = 3\cdot20,\ \tau_0 = 1\cdot69 \times 10^{-6}\text{ sec.},\ C = 2\cdot67 \times 10^5.$$

This seems to confirm that γ has a value somewhat higher than that usually accepted. The value of τ_0 seems rather small in comparison with the best experimental data, and it would have been even smaller had we used an initial $\varepsilon^{-\gamma}$ spectrum. It would be difficult, however, to draw any inference from this fact, owing to the uncertainty which still exists in the low-energy part of the spectrum.

The effect of a departure θ of the measured meson tracks from the vertical direction was also considered, but it was found that with a distribution of the form const. (l cos $\theta - r$ sin θ) valid for parallel counters of length l cm., placed r cm. apart from one another, no important errors should occur up to a maximum value of 30° for θ, which appears to be a reasonable upper limit.



The graph shows the accord between experimental data and theoretical curve.

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March 25.

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[1] *Nature*, **158**, 450 (1946).

[2] *J. Franklin Inst.*, **236**, 9 (1943).

[3] *Ergeb. Exak. Naturwiss.*, 40 (1938).

Diffuse Bands on Laue Photographs of Silver Chloride Crystals

In a recent paper and in a communication in *Nature*[1], Laue photographs of large silver chloride crystals were published, showing diffuse bands and spots. It was then suggested that these bands were, at least partly, not of thermal origin, but due to the presence of definite lattice defects, parallel to the cubic planes and axes. The experimental fact that such crystals, when irradiated with ultra-violet light, showed an 'optical etching effect' parallel to the cubic planes (as evident from the reflexion of incident light by the irradiated crystals, which was similar to that shown by chemically etched crystals) was considered to support this conclusion. Moreover, on a photograph of a crystal cooled with liquid air, taken at the time the above paper was published, the diffuse pattern was still visible.

In view of the fact that in practically all other cases of diffuse bands published so far[2] they are temperature-dependent, it was worth while to make such photographs anew, now conditions for obtaining liquid air are again more favourable. These photographs show clearly that with silver chloride also the bands are of thermal nature, as they disappear practically completely at low temperatures. The apparently opposite effect obtained in the former experiment was probably due to insufficient cooling of the crystals. Diffuse bands due to lattice distortions of the type discussed in our note are thus, so far as known to us, not observed with certainty in any case[3]. The remarkable etching effect shown by the irradiated crystals remains, however, an indication that actually deviations parallel to cube planes are present in the crystals.

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[1] Burgers, W. G., and Tan Koen Hiok, *Physica*, **11**, 353 (1946); *Nature*, **157**, 19 (1946).

[2] Lonsdale, K., *Proc. Phys. Soc.*, **54**, 314 (1942).

[3] We are not discussing here such effects as are observed on photographs of age-hardening crystals (Preston, G. D., *J. Sci. Instr.*, **18**, 155 (1941)), of asbestos crystals and the like (cf. Guinier, A. J., *Proc. Phys. Soc.*, **57**, 310; 1945) and also the 'extra reflexions', observed with special diamonds, the exact nature of which seems not to be precisely known (Lonsdale, K., *loc. cit.*; Lonsdale, K., and Smith, H., *Nature*, **148**, 112, 257 (1941); also Guinier, A. J., *loc. cit.*).

X-Ray Diffraction Studies of Yielding in Mild Steel

THE distribution of plastic deformation in a cold-stretched mild steel bar has been studied by X-ray diffraction methods. Using the back-reflexion technique with cobalt radiation, two spotty rings were obtained by reflexion of the $K\alpha$ doublet from the (310) plane of iron. Plastic deformation in the specimen was indicated by a blurring of the spots of the diffraction pattern as the individual crystals, which gave the reflexions, became distorted. An X-ray beam of about 1 mm. diameter was used to explore the distribution of the deformation.

A normalized, 0·26 per cent carbon steel bar was stretched in a tensile testing machine until the so-called 'Lüders lines' or 'Hartmann bands' appeared over part of its length. These Lüders lines are parallel strain bands, inclined at approximately 45° to the bar axis, and made visible by the flaking-off, along the bands, of the oxide scale produced by the normalizing process. The average plastic extension within the region showing Lüders lines was found from gauge marks to be about 1·5 per cent.

Fig. 1 represents a section of the bar including part of a region of strain markings. Figs. 2 *a–d* show portions of X-ray patterns obtained from the particular areas of the bar indicated in Fig. 1. In each case the chosen area was first etched with nitric acid to remove the oxide layer.

The pattern, Fig. 2 *a*, was obtained from an area within a region showing no strain markings. The sharpness of all but a few of the spots indicates that only slight plastic deformation occurred in this region. In the pattern, Fig. 2 *b*, obtained by directing the X-ray beam on a Lüders line (that is, on a band from which scale had peeled) almost all spots are diffuse, indicating marked plastic deformation.

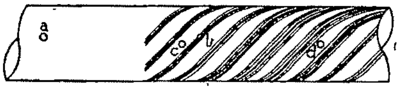

Fig. 1. PORTION OF A STRETCHED STEEL BAR, SHOWING PART OF A REGION OF LÜDERS LINES

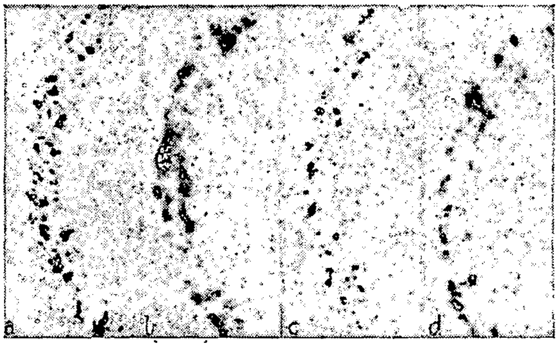

Fig. 2. X-RAY DIFFRACTION RINGS OBTAINED BY BACK-REFLEXION FROM POINTS *a*, *b*, *c*, *d* OF FIG. 1

Figs. 2 *c* and *d* illustrate patterns obtained from areas lying between two Lüders lines. For such areas chosen near the boundary of a region showing the strain bands, only a few of the spot reflexions are blurred, as in Fig. 2 *c*. However, in patterns such as Fig. 2 *d*, from such areas chosen near the centre of a region of Lüders lines, a greater proportion of the spots are blurred, although the blurring is still less extensive than in Fig. 2 *b*.

Since the region of Lüders lines grows as a bar is stretched, these results show that the amount of plastic deformation is much greater between Lüders lines formed at an early stage of the stretching than between those formed later, and is very slight between the most recently formed lines. These observations lead to a picture of the mode of yielding in mild steel similar to that proposed by Jevons[1]. At first a narrow band of material at about 45° to the axis of the bar undergoes plastic strain of the order of 2 per cent. With increased stress, other such bands, separated by regions of very little deformation, appear at successive intervals along the bar. As the region of strain-bands grows by the formation of new bands, the earlier formed lines grow laterally by an increase in plastic distortion on either side. Thus the distribution of plastic deformation becomes more uniform, and eventually the whole bar undergoes plastic strain of the order of 2 per cent.

The variation of deformation across a set of Lüders lines may be demonstrated readily by the use of an X-ray beam diverging from a point source through a long slit. A strip of the specimen at right-angles to the lines is irradiated, and gives diffraction rings broadened along their diameter parallel to the strip. Across the broadened portion of the rings, the spots are alternately sharp and diffuse, corresponding to the alternation of plastically deformed and underformed regions along the irradiated strip. Good resolution may be obtained by a suitable choice of radiation.

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[1] Jevons, J. D., "The Metallurgy of Deep Drawing and Pressing", Chapter 7 (1940).

Recrystallization of Duplex Brass

ALTHOUGH the deformation and subsequent recrystallization of pure metals and single-phase alloys has been widely studied, little work has been done on the deformation of duplex alloys, that is, alloys containing two phases, and we know of no published work on their behaviour on annealing after cold work. The two phases will normally possess quite different physical properties. On application of a stress, the phase with the lower elastic limit will be plastically deformed at a lower stress, and the distribution of the deformation in the two phases will depend on their relative elastic limits and work-hardening characteristics. Recrystallization in the two phases can be expected to occur after different total deformations and at different temperatures, not only because of their different chemical compositions, but also because of the different extents to which deformation occurs in the crystals of the two phases.

The progress of recrystallization was studied in a duplex brass (60 per cent copper, 40 per cent zinc), the most familiar example of an alloy containing two deformable phases. The recrystallization was followed in two ways, namely, by the metallographic technique of electrolytic polishing, etching and microscopic examination, and by an X-ray diffraction method. From the character of the lines of the two phases which appear on the one diagram, the state of deformation or recrystallization can be assessed (see Fig. 1). Figs. 2 and 3 are photomicrographs which illustrate how recrystallization of the two phases can be distinguished metallographically. In all experiments there was a good agreement between the results obtained by microscopic examination and by the X-ray method.

A series of specimens was prepared from the gauge lengths of tensile specimens which had been strained by different amounts and then annealed. Some of the results obtained are summarized in the accompanying table. It is clear that the α-phase tends to recrystallize at lower temperatures and at lower deformations than the β-phase. This is to be expected, because the α-phase is softer and more readily deformed than the β-phase.

RECRYSTALLIZATION IN THE PHASES OF DUPLEX BRASS

% Elongation	Phases	State of recrystallization after annealing at			
		400° C.	425° C.	450° C.	500° C.
36	α	partly	fully	fully	fully
	β	none	partly	fully	fully
30	α	partly	fully	fully	—
	β	none	commenced	partly	
24	α	partly	partly	fully	fully
	β	none	none	partly	fully
18	α	none	just comm.	commenced	—
	β	none	none	none	

To determine the effect of the relative quantities of the two phases on recrystallization, specimens of brass wire (40 per cent zinc) were quenched from 750°, 650° and 550° C. respectively, thus producing alloys containing approximately 80, 50 and 30 per cent of the β-phase. Wire-drawing was employed as a means of deformation, since a greater amount of deformation could be imposed on the alloy than in a tensile test. The wires were cold drawn from 0·186 in. to 0·073 in. (85 per cent reduction in area), and specimens annealed at 300°, 350°, 400° and 450° C. for half an hour. There was a general tendency for the β-phase to recrystallize to a larger extent in the alloy containing the least quantity of the β-phase. For example, on annealing at 400° C., the β-phase in the 80 per cent β-alloy had just commenced to recrystallize; it was partly recrystallized in the 50 per cent alloy; and fully recrystallized in the 30 per cent alloy. A β-crystal will take part in the deformation to a larger extent when it is embedded in a matrix of soft α-crystals than when it has many hard β-crystals as neighbours. Consequently recrystallization will take place at lower temperatures in the former case.

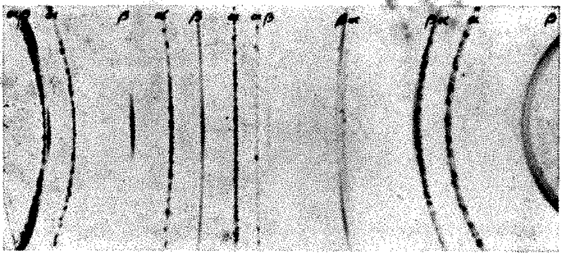

Fig. 1. X-RAY POWDER PHOTOGRAPH OF AN α-β BRASS SPECIMEN. THE α-PHASE IS NEARLY FULLY RECRYSTALLIZED, WHILE THE β-PHASE IS STILL DEFORMED

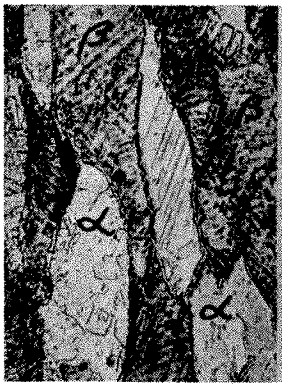

Fig. 2

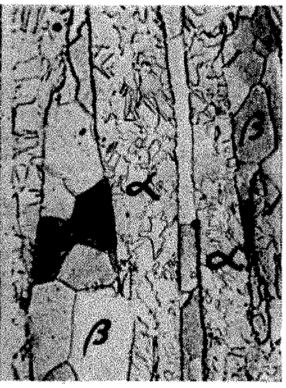

Fig. 3

Fig. 2. SPECIMEN IN WHICH THE α-PHASE IS PARTLY RECRYSTALLIZED; THE β-PHASE IS STILL DEFORMED

Fig. 3. SPECIMEN IN WHICH BOTH PHASES HAVE FULLY RECRYSTALLIZED

Photomicrographs × c. 400

In all the experiments described above, the crystals of the α-phase recrystallized before those of the β-phase. However, the β-phase commenced to recrystallize *before* the α-phase in a series of experiments where the original wire was air-cooled from 800° C., drawn to 85 per cent reduction in area and specimens annealed in the usual way. At 250° C. the β-phase had partly recrystallized, whereas the α-phase was still deformed. The composition and the relative proportions of the two phases were similar to those in alloys used previously. The only difference between this series and the other series was that these alloys had been *air-cooled* from 800° C., whereas the other alloys had been *water-quenched*. This suggested that a change in properties as a result of the order-disorder transformation might be responsible for the reversal in the sequence of nucleation.

To test this theory, two pieces of brass wire were annealed at 800° C., then slowly cooled. The first specimen was water-quenched from 475° C. (that is, just above the critical temperature of the order-disorder transformation), while the other was quenched from 400° C. (just below the critical temperature). Both wires were then drawn as in the other experiments, and specimens were annealed. X-ray and microscopic examination revealed that, in the wire quenched from *below* the critical temperature, the β-phase had partly recrystallized at 250° C., while the α-phase was still completely deformed. In the other wire, the α-phase commenced to recrystallize at 275° C., whereas the β-phase did not start to recrystallize until 300° C.

Thus the behaviour of duplex brass on annealing after deformation is quite complex. Order-disorder transformations do not, of course, occur in all alloys, but the effect of the relative proportions of the two phases is of general application. It is also evident that consideration must be given to the slope of the phase boundaries, for changes in composition of a phase will have some influence on its behaviour during recrystallization.

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March 31.

The Harmonic Cord

While the possibility of vibrating a thin cord regularly in a flat plane from a tuning fork has long been known as the 'Meldé cord', from its discoverer; and the development of large cigar-shaped loops on a thick stretched cord, corresponding to the fundamental and harmonic frequencies, by variable-speed electric-motor drive adjusted to the natural periods of the cord, has followed as a physical laboratory demonstration; it is not generally realized that a multiplicity of frequencies may be simultaneously developed on the same cord, by suitably designed mechanisms.

When two or more rotary vibrations having harmonic relations are superposed, stable figures may be produced alike for concurrent or opposed rotations, often very beautiful in form. The section at any position on the cord, which may be called the 'orbit' at that position, will be a trochoidal figure, twin or multiple elliptic if elliptic instead of circular rotations are imposed. The complete enclosing figure, which may be called the 'envelope', may have internal or external 'cells', corresponding to the internal or external loops of concurrent or opposed rotation trochoidal curves developed with the harmonic relationships chosen.

If two rotations which are not perfectly tuned to a harmonic relation are superposed, the whole envelope will rotate slowly for a small tuning error, and rapidly for a large one; while the evolution of form as a second vibration is impressed on an existing fundamental or harmonic vibration envelope is very fascinating to watch.

Where two rotations in the same direction and with nearly related frequencies such as 9 : 10 are superposed, the cord appears to pulse rapidly longitudinally as the addition and subtraction of amplitudes alternately occur; sometimes apparently similar effects may be noted temporarily while tuning other frequencies together.

A high harmonic of small amplitudes may be superposed on large fundamental or low harmonic cigar-shaped envelopes, and may produce a remarkable ripple effect on these surfaces, probably rotating over them.

With elliptic rotations there appears to be a pronounced tendency towards circularity, apparently by transference of energy between the two octave-related vibrations involved, as is readily seen when an elliptic drive is given to the cord. However, an interesting elliptic case is a circular drive at a considerable angle to the axis of the cord, so superposing a longitudinal wave on the transverse wave in a circular envelope system, and in effect producing an elliptic rotation; this produces an envelope which contains various octave orbits (but not accurately in planes normal to the cord axis) which may rotate slowly and show interesting cell and phase changes as it does so.

If rectilinear vibrations in different planes are impressed on the cord, the orbits are Lissajous figures; the cells and envelope forms evolving with change of phase relationships if the tuning is imperfect, no rotation of the envelope occurring in this case.

Up to the present, no facilities for the difficult photography of this figuring have been available; and sketching does not adequately or accurately record the complex and transparent forms which can be seen. It may be noted that musical instrument strings show similar orbits on a microscopic scale, as was first demonstrated by me in 1911, but with the figuring so slim that the beauty of the envelope forms could not be appreciated.

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Mortality Required to Prevent Population Increase

Biologists have often calculated the vast numbers which would be reached in a relatively short period by the descendants of a single pair of insects or other fecund animals if all of them reproduced at the normal rate before dying. Such calculations are used to illustrate the high potential rates of population increase, or the severity of the natural checks to increase, or to show the very high mortality required to keep a fecund population within normal limits. It should, of course, be recognized that, in many cases, reductions in the rates of reproduction and development also play an important part in limiting increase. However, the purpose of this note is to direct attention to the fact that, in certain calculations of the 'necessary mortality', there is a striking fallacy.

An example may be taken from a paper by Payne[1] on the ecology of *Microbracon hebetor* Say and its host, *Ephestia kühniella* Zeller. The latter has "a total period from egg-laying to egg-laying of 62 days at 32° C., with 52·5 % of the adults females, and the number of eggs per female 181. The offspring from one female at the end of a year is 30,428,590,122 counting five generations to a year. The percentage that must die to keep the number constant is 99·99999999993." The astronomical size of these figures is due to the assumption that there is no mortality of offspring before reproduction, until the fifth generation, an unlikely event with most animals and certainly unrealistic in the case of *Ephestia*. If we make the more natural assumption that the mortality is the same in each generation, the surplus offspring per female in each generation is approximately 179, or 179 × 5 = 895 in five generations; to eliminate this surplus a mortality of less than 99 per cent in each generation is sufficient.

The origin of the misconception is apparently in a method developed by Bremer[2]. Considering an insect population of n individuals, of which a constant proportion n/b are females, each of which lays a eggs and then dies, Bremer expressed the proportion of the offspring that must be destroyed, in order to keep the number down to n, as $na/b - n$, or $n\,(a/b - 1)$. He called $a/b - 1$ the "normal coefficient of destruction", that is, the necessary mortality of offspring as a multiple of n. He also expressed this necessary mortality as a proportion of the number of offspring, calling this value the "normal destruction quotient", which is $n\,(a/b - 1)/na/b = 1 - b/a$. This is correct. Bremer then expressed the "normal coefficient of destruction" for a year, in which there are c generations, as $a^c/b^c - 1$, and the corresponding "normal destruction quotient" as

$$q_c = 1 - b^c/a^c. \qquad (1)$$

Both these formulæ imply that there is no mortality (except the death of adults after reproducing) for c generations.

Bremer's formula (1), and his correspondingly fallacious numerical example, were quoted by Blunck[3], and from him by Uvarov[4]. Both these authors called q_c the *coefficient* of destruction. Payne[1] also followed Blunck in confusing the coefficient and the quotient; moreover, the formula (1) is misquoted in her paper, but clearly she did not use it in that form.

Since the above error occurs in papers of some importance to insect population studies, it is desirable that it should be pointed out. If the method is to be used for periods embracing more than one generation, it is best to assume the same rate of mortality in each generation. Then the 'coefficient' will be $a/b - 1$ and the 'quotient' will be $1 - b/a$, whether one or many generations are involved. When such regular mortality cannot be assumed, the method is applicable only to single generations.

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March 21.

[1] Payne, N. M., *Ecol. Mon.*, **4**, 1 (1934).
[2] Bremer, H., *Z. angew. Entom.*, **14**, 254 (1929).
[3] Blunck, H., *Z. Pflanzenbr.*, **39**, 1 (1929).
[4] Uvarov, B. P., *Trans. Ent. Soc. Lond.*, **79**, 1 (1931).

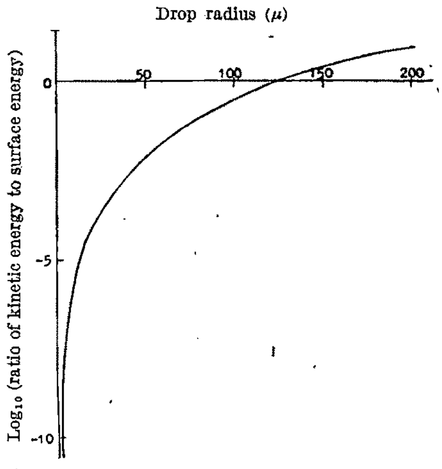
Collisions of Cloud Droplets

WHETHER cloud droplets coalesce on impact is a problem of obvious theoretical and practical interest, having bearings on theories of rain formation, methods of fog dispersal, the stability of clouds, etc. A major obstacle in the way of providing an answer to this question is the difficulty of simulating in the laboratory the conditions that obtain naturally in clouds. Nevertheless, in July 1941, I made some experiments in connexion with this subject at the Imperial College with the aid of facilities kindly provided by Prof. (now Sir George) Thomson, and with the help of Dr. J. Mazur, and the results obtained may be of interest to others concerned with the same problem.

The liquids used were pure water, fluess oil, absolute alcohol, α-chloro-naphthalene and benzene, these liquids being chosen for their widely differing physical properties. The drops were produced by spraying from an atomizer, and their behaviour in a small draught-proof chamber was observed through a microscope by light reflected from their surfaces. The outstanding result of the experiments was that droplets were never seen to coalesce on impact, neither when there were 'head-on' collisions nor when the drops, which were found to carry both kinds of electric charge (presumably due to their method of production), were made to collide more violently by applying an electric field. In all, the behaviour of many hundreds of droplets of each liquid was observed. Unfortunately, the apparatus limited careful observation to drops up to 2 μ radius, and this is less than the size that occurs most frequently in clouds. However, if the following explanation of the non-coalescence of these minute drops is correct, it may be inferred that cloud droplets may not coalesce on impact until they are much larger than this—probably greater than 50 μ radius, which is the size of drizzle drops.

Two small drops will separately assume the shape of minimum surface energy, a sphere. If they coalesce, the joint drop will again be a sphere in which the surface energy has a new and lesser minimum. During amalgamation, the drops will be distorted, and, though the mechanics of coalescence are not known, the distortion may cause an increase in surface energy. Such an increase of surface energy, though it would be small compared with the total, would constitute a barrier to coalescence: if it is overcome, the drops will amalgamate; if not, they will rebound. In this experiment the only mechanical energy available to overcome such a barrier was the kinetic energy of the drops, due either to fall under gravity or the electric field, and, unless this energy is comparable with the possible increase in surface energy due to distortion, amalgamation cannot take place. The graph shows how, for a water drop, the ratio of the kinetic energy at terminal velocity to surface energy varies with the drop size.

It is clear that the kinetic energy is quite insignificant for very small drops, and even at 50 μ radius the ratio is only 0·01. It is true that collisions between drops of different sizes are more likely than between drops of the same size; but in such cases the kinetic energy destroyed on impact will be much nearer that of the smaller drop. Hence, small as it is in comparison with the surface energy of the latter, it will be even more insignificant compared with that of



RATIO OF KINETIC ENERGY AT TERMINAL VELOCITY TO SURFACE ENERGY AS A FUNCTION OF SIZE OF DROP the larger drop, and coalescence is unlikely both for impact of small drops and for large drops with small ones. In this connexion it is of interest to record that when a large drop was formed in the experiments, it plunged through the chamber scattering the smaller ones in its path.

I am indebted to the director of the Meteorological Office for permission to communicate this letter.

W. C. SWINBANK

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April 15.

Silver Chloride Plates for Infra-Red Spectroscopy

ALTHOUGH rock salt has been commonly used in the construction of absorption cells for infra-red spectroscopy, it has the inherent disadvantages of being opaque beyond $15\ \mu$, and of being attacked by water. Silver chloride, however, is transparent up to $25\ \mu$ and is completely resistant to water.

Fugassi and McKinney[1] have briefly described a method for making silver chloride plates by rolling the fused material. Difficulties were encountered in rolling and casting when trying to repeat this work. Silver chloride plates of suitable quality, however, were prepared in this laboratory by the following method.

All operations were carried out in a darkened room lit by a 40-watt bulb. Silver chloride was precipitated from silver nitrate and sodium chloride, taking care that as little silver nitrate as possible was occluded in the precipitate. The latter was filtered off and dried at 105° C. A piece of porous porcelain (2 in. × 2 in. × ⅛ in.) was heated to redness over a Bunsen burner, and a few grams of the dry silver chloride melted on (melting point AgCl, 455° C.). The orange liquid was spread out in a layer about ½-mm. thick, and any scum scraped to the side using a second piece of porcelain. When cold, the sea-green layer was covered with a film of nitrocellulose lacquer and the whole immersed in a 20 per cent solution of sodium thiosulphate for 15–20 min., after which time the opalescent silver chloride layer could be peeled off the porcelain.

After washing the silver chloride in acetone, it was pressed between polished stainless steel disks in a steam-heated press at 4 tons per square inch for 2-min. periods. The plates so produced were stood in gaseous chlorine for a number of hours, in order to ensure complete clarity, and then repressed.

This method provides silver chloride plates about ¼-mm. thick, transmitting uniformly 65 per cent of the incident radiation between $5\ \mu$ and $15\ \mu$—the region studied. They are rigid and tough and suitable for the construction of absorption cells, and are only slowly darkened on exposure to daylight. Artificial light had no detectable influence on the plates over a period of four weeks.

Kremers[2] has described a method, based on a silver sulphide coating, of protecting silver chloride plates against solarization.

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April 7.

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[1] Fugassi and McKinney, *Rev. Sci. Instr.*, **13**, 335 (1942).

[2] Kremers, *J. Opt. Soc. Amer.*, **35**, 349 (1946). See also Fuoss, *Rev. Sci. Instr.*, **16**, 154 (1945).

Distortion of Fungal Hyphæ in the Presence of Certain Inhibitors

Brian, Curtis and Hemming[1] have recently reported the production by *Penicillium Janczewskii* of a factor having little antibiotic action but causing characteristic distortion of fungal hyphæ growing in its presence. This substance, isolated in a crystalline state and given the formula $C_{20}H_{20}O_9$[2], has been termed 'curling factor'. The description and illustrations of the stunting and curling caused by this factor are strongly reminiscent of the appearance of hyphal tips growing in the presence of a number of relatively simple inhibitory substances (notably methyl *p*-hydroxybenzoate[3]) encountered by me during the course of fungistatic investigations using *Aspergillus niger*, *Penicillium roqueforti* and *Byssochlamys fulva*. Brian, Curtis and Hemming, while referring to earlier records of similar morphological effects caused by the metabolic products of organisms, consider their effect to be distinct from any previously described for pure chemicals. I consider that the behaviour of the esters referred to above is likely to come into the same class of phenomenon as claimed for 'curling factor'.

My investigations have involved hyphæ growing on Czapek's agar (*p*H 4–5; nitrogen as nitrate), and, although records of distortion have been incidental to the principal purpose of the work, certain aspects seem to merit comment. The appearance of affected hyphæ is most characteristic, involving stunting, multiple branching and curling in a peculiar zigzag form. That the phenomenon is not directly associated with the inhibitory action of the substance is seen in a comparison of homologous esters, where increasing chain-length, although markedly increasing fungistatic activity[4], does not proportionately enhance the distortion effect. On the basis of concentration of ester causing a given level of inhibition, the lowest esters, notably methyl, cause much greater distortion. As a result, little, if any, curling of hyphæ is to be seen with those concentrations of higher esters (such as butyl to heptyl) that are low enough to permit growth. Distortion has also been observed for anisic, salicylic and benzoic acids and for phenol; with *p*-hydroxybenzoic acid itself and the *m*-isomer, the effect is either small or absent.

It is of interest to examine the quantitative nature of the relationship. Brian *et al.* have found their 'curling factor' to be remarkably active, permitting marked stunting at 6×10^{-6} molar. In contrast, the molar concentration of methyl *p*-hydroxybenzoate, permitting ready detection of the similar effect with *A. niger*, is of the order 300×10^{-6}—still very much less, however, than that required for the complete inhibition of growth (approx. $3{,}000 \times 10^{-6}$). It is, of course, possible that distortion results not directly from the action of the inhibitor but from a product of the mould's own metabolism with inhibitor serving as precursor. If this were so, the concentration of such a factor might well be very much less than that of the inhibitor initially supplied.

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University of Sydney.
March 19.

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[1] Brian, P. W., Curtis, P. J., and Hemming, H. G., *Trans. Brit. Mycol. Soc.*, **29**, 173 (1946).

[2] McGowan, J. C., *Trans. Brit. Mycol. Soc.*, **29**, 188 (1946).

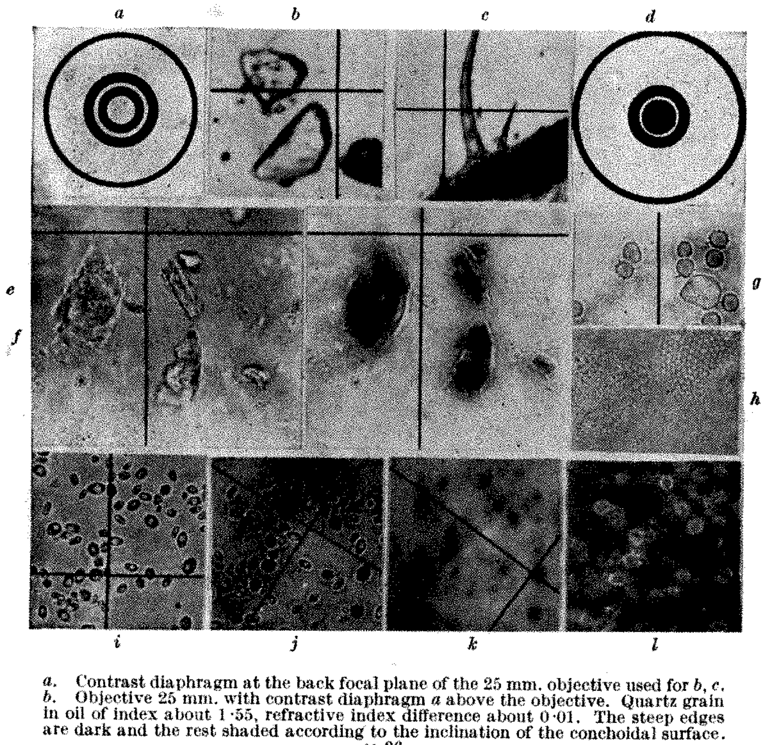
[3] Vincent, J. M., *J. Soc. Chem. Ind.*, in the press.

[4] Cavill, G. W. K., and Vincent, J. M., *J. Soc. Chem. Ind.*, in the press.

PRODUCTION OF CONTRAST IN THE MICROSCOPE IMAGE BY MEANS OF OPAQUE DIAPHRAGMS

By Dr. A. F. HALLIMOND
Geological Survey and Museum

'PHASE-CONTRAST' methods have recently been widely used to improve the visibility of small transparent objects. The illumination is restricted to a narrow cone by means of an annular diaphragm placed under the condenser, and the direct beam passes through a conjugate annular 'phase-plate' near the upper principal focus of the objective. A theoretical explanation of the effect was given in the original paper by Zernike. It appears to me, however, that Zernike's explanation is insufficient through the omission of an important physical factor, which seems to have been only partly recognized in the later paper by Kohler and Loos. "The details of such an object (transparent) are distinguished only by unequal thickness or refractive index, i.e., they impose on the incident light only phase differences." This statement by Zernike ignores the effect of the inclination of the surfaces that is in fact nearly always present. Methods which render inclined surfaces visible have long been employed by mineralogists for refractive index determination by the Becke line and Schroeder effect. The accompanying photographs (*a–l*) suggest that useful contrast may be obtained by an arrangement of opaque stops, without the use of a 'phase-plate'. It may perhaps be convenient to use the term 'stop-contrast' to distinguish this method from that involving the use of the phase-plate.



a. Contrast diaphragm at the back focal plane of the 25 mm. objective used for *b*, *c*.
b. Objective 25 mm. with contrast diaphragm *a* above the objective. Quartz grain in oil of index about 1·55, refractive index difference about 0·01. The steep edges are dark and the rest shaded according to the inclination of the conchoidal surface. × 36.
c. As in *b*. A leaf-hair in water. There is little injury to the definition. × 36.
d. Contrast diaphragm at back of 4 mm. objective used for *f*, *g*, *h*, *j*, *k*, *l*.
e. 4 mm. 0·85 N.A., *no diaphragm above objective*, the condenser giving ordinary conical illumination. Scales and rouleaux of kaolinite in balsam, refractive index difference about 0·020. Detail is clear with marked Becke lines, but there is little contrast with the background. × 300.
f. 4 mm. 0·65 N.A., contrast diaphragm above the objective as *d*, etc. Detail is still clear, but there is now a marked contrast with the background. × 300.
g. As in *f*. Red and white blood corpuscles. × 300.
h. As in *f*. Diatomite in liquid of refractive index 1·39. × 300.
i. 4 mm. 0·85 N.A., *no diaphragm above the objective*, ordinary conical illumination as in *e*. Yeast in water. Some of the cells in these photos have moved during the exposures. × 300.
j. 4 mm. 0·65 N.A., contrast diaphragm above the objective as in *f*, etc. Yeast is rather strongly refractive and there is little addition to the detail already visible in *i*. No injury to definition.
k. As in *j*. The outer zone of the contrast diaphragm *d* has been covered so that only the direct beam through the annulus is being used. There is considerable loss of definition, the focus in this case being very deep.
l. As in *j*. The annulus has been covered so that only the outer zone of the contrast diaphragm *d* is being used. This gives in effect a 'dark ground' illumination, and the image chiefly consists of bright lines due to the steep edges of the cells.

In phase-contrast, if a given 'point' in the object is to be regarded as an element of a prism rather than as a horizontal surface, the corresponding image of the condenser annulus at the back of the objective will appear as a circle which no longer coincides completely with the annular phase-plate. Part of the 'direct' beam then reaches the eyepiece in differing phase from that which may still traverse the phase-plate, and the image is consequently weakened by interference. By adjusting the opacity of the phase-plate, the amount of light in the two parts of the beam can be matched so as to produce maximum interference. Such an explanation would seem to account for many of the results obtained by phase-contrast, though the full range of these effects has scarcely yet been investigated. The interference method is very efficient in extinguishing the light, but it is open to the objection that when the phase-plate has been adjusted to give maximum contrast for a certain small angular deviation, the more deviated light from other points in the object will mainly miss the phase-plate and will not be extinguished. In such cases an opaque diaphragm may give a wider range of extinction.

Stop-contrast is obtained by using a narrow annular opening below the condenser (in the present case a lens of about 1½ in. focal length), with a conjugate annular opening near the upper principal focus of the objective. Light deviated by the object is eliminated by surrounding the open annulus at the objective with an opaque diaphragm, which in its simplest form might cover the rest of the objective. Such an arrangement is, however, inadmissible since it reduces the aperture and damages the resolving power (photo. *k*). The opaque part of the stop must therefore be usually limited to a certain angular distance immediately on each side of the annulus (*a*). It is sometimes convenient to darken the whole of the relatively small central area (*d*). With a complete stop, practically all the deviated light contributing to the Becke and Schroeder effects would be eliminated. With the dark annuli some extremely deviated rays will still get through the open outer zone, so that steep edges and objects of high refractive index difference may still show a modified Becke line ; but the desired object may be practically free from it, dark contrast being produced instead.

The following incomplete statement indicates the angular values concerned. The maximum deviation that can be produced by a cylindrical object is that for a ray entering and emerging at the grazing angle and will equal $2(90-\theta)^\circ$, where θ is the critical angle. For refractive indices 1·33 (water) and, say, 1·35 (object), $2(90-\theta)$ is 20° in the liquid. If the opaque part of the diaphragm at the back of the objective intercepts rays that occupy this angle, such an object will appear dark except at points near the centre. For low-power objectives with low numerical aperture, the angles that can be covered are much narrower than this, but the method will be sensitive to small differences in refractive index. Higher powers, on the other hand, with numerical aperture about 1·0, will accommodate annuli covering a wider angle that may approach 20°, and they can be made effective for objects of wider deviation.

The accompanying photographs illustrate the results obtainable with low- and medium-power objectives (Cooke, 25 mm., 0·15 N.A. and 4 mm. N.A. 0·65), by means of narrow conical illumination with opaque stops partly covering the back of the objective as shown in *a* and *d*. In these cases the depth of focus is very small and only parts of the object can be in focus, the tendency being to obtain an 'optical section'. Phase-contrast photographs of kaolin were reproduced in *Nature*, **158**, 621 (1946).

The comparison photographs *e* and *i* were taken with narrow conical illumination. This is probably the most satisfactory form of ordinary illumination for objects of small refractive index difference, since it gives a moderate Becke effect without undue loss of light, but the image is mainly due to this effect.

Photographs *c*, *f*, *g*, *h*, *j* indicate that the contrast diaphragm causes no great injury to the resolution of details in the object. *k* and *l* were taken through the annulus and outer zone of the objective, used separately. Neither would supply the detail observed in *j*, although the only difference is that in *j* both areas are open simultaneously. The improvement is presumably due to interference in accordance with Abbe theory.

In ordinary narrow-aperture illumination, a small object in liquid of lower refractive index appears light when the tube is raised, almost invisible when in the focal plane, and dark when the tube is lowered. For a simple isolated object the latter effect resembles that given by contrast methods, but is only produced when the object is somewhat out of focus. When the object is in the focal plane, the use of a contrast diaphragm produces a similar darkening, and the details are in focus. For a complex rugose (or finely granular) object such as the kaolin scales in *e*, the Becke lines overlap in the interior of the object areas, producing a confused mottling which in fact only an experienced observer would interpret as due to a solid object. It is in such cases that the use of contrast methods seems most likely to be advantageous.

The annulus in *d* was purposely made narrow to test the effect on resolution. It is not suggested that this would be necessary in all cases.

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INDUSTRY AND RESEARCH IN THE SHEFFIELD AREA

THE Federation of British Industries has been holding in recent months a series of conferences on that vital question of the present time, the dependence of progressive industry on research. One of these regional conferences was held in Sheffield on June 5 to discuss the bearing of research on industry in the case of the smaller manufacturing concerns. The problems were considered from two aspects: the first, at a morning session, presided over by Sir Walter Benton Jones, dealt with the part research could play in promoting industrial efficiency, exports and a higher standard of living, with special reference to the industrial problems of the Sheffield area. Sir Walter, in opening the meeting, directed attention to the valuable conclusions of previous conferences, and stated that industry values highly the growth of special research. The afternoon session, Lord Dudley Gordon being in the chair, was devoted to the case of the smaller manufacturing concern which could not afford the cost of a research department, and consideration was given to the research organisations and facilities which could serve it.

The subject of "Research and National Recovery" was discussed by Sir William Larke in a paper full of wise advice of an encouraging and stimulating character. He pointed out that our industrial production needs to be increased above that of 1938 by at least 25 per cent under conditions of a shortage of raw materials and man-power. These requirements point to the need for technical advances, at least as great as those which were achieved during the War. He regards shortage of coal as the principal factor preventing our economic recovery. This difficulty demands still more attention to efficient use, by increased supervision, by continuing to demand of the suppliers fuel of the appropriate quality, and by the provision of more efficient fuel-using plant. Further, our general production efficiency must be at a higher level than that of our competitors. The support of research and closer collaboration of all elements concerned with industry and research are necessary. A survey made by the Federation of British Industries of research activities in British industry has shown a total of some 40,000 staff, of whom 10,000 are graduates of a university or equivalent standard. The total expenditure by industry on research, Sir William said, has increased fourfold in the last ten years, and is now in excess of £25,000,000 per annum, or at least 0·5 per cent of the total value of our annual industrial production. This situation and the potentialities of rapid application of the results of research and discovery to the improvement of industrial efficiency should provide the means of strengthening our competitive power in world markets. The achievements in the face of the overwhelming difficulties of 1940 onwards give hopes of inspiration and encouragement for the future.

Dr. G. P. Jones, discussing the lessons of history in a paper entitled "The Historical Growth and Economic Development of Sheffield Industries", had perforce to limit his scope to steel-making and cutlery. He showed how much we are dependent on the competence of our forefathers, and in what degree an easy livelihood and survival of two terrible wars are owed to their efforts. The historical aspects of the question were also dealt with by Lord Dudley Gordon in reference to valuable contributions to industry which had been made by Sheffield metallurgists. These contributions, as it was put by Sir Charles Goodeve in his summing up of the discussion, showed that confidence is restored by the existence of a momentum of the past.

Prof. R. J. Sarjant, in a paper on "The Industrial Problems of the Sheffield Area and their Solution by Methods of Research", showed how complex the research problems of industry are becoming with the rapid advancement of engineering practice. While the laboratory is still the place for pioneer development, modern research has to proceed to the study of the maze of variables encountered in the plant. This entails the service of the balanced research team—trained research workers, observers and technicians—which in general can only be supplied by the larger research organisation, and in regard to the smaller firm can only be provided by co-operative action. The major problem at present appears to be the better utilization of existing resources. This involves co-ordination of effort, better training and adequate contacts between industrial and research personnel. There is, too, the place of the university, which is, so to speak, on the doorstep. Its function is to inspire the spirit of a 'divine discontent' so useful to research-mindedness, to foster the development of methods which apply to the solution of sociological and technical problems, and to be at the spear-point of the development of research.

Lord Dudley Gordon referred to the potentialities which lie in the institution of the Engineering Research Board. It is patent that demand for men, buildings and equipment has outstripped the supply. It is accordingly expedient to examine what can be done in the circumstances. Where there is no research department, there should be individuals who can collect and study new knowledge, and apply the findings of research done by others to immediate industrial problems. Internal questions of the attitude of management, psychological outlook and methods of organisation must be considered. There are valuable assets in the technical colleges, the scientific societies and advisory services to put inquirers in touch with sources of information. The Research Secretariat which the Federation of British Industries has set up is a valuable instrument in this last respect.

In a paper on "Sheffield Research Organisations, Facilities and Activities", Dr. W. J. Rees outlined the activities of the University, its functions and contributions in relation to the matters discussed, the achievements of the works' laboratories, the wide extent of the work of the research associations, and the facilities available in the technical industries and the efficient library services.

Dr. F. C. Lea finally tackled the main problem of the smaller firms, in a paper entitled "The Smaller Firm and its Application of Research". He took the view that of necessity the small firms have a real live interest in research; they have an essential place in the industrial structure; they can be helped and they can help themselves. The first essential is the need for adequate scientific and technical training of owners and managers. This means better technical colleges and more use to be made of them. These should be provided with staff and equipment to assist in solving the problems of the small firm. Managers should be familiar with what is being done not only in Great Britain but also in other countries. They should be ready, too, to buy new plant and to use new methods.

In the discussion which followed, many points of interest were raised, particularly around the matter of the fear which some managements have of admitting competitors to see what are considered to be secret processes. It was shown, however, that such fears are groundless, and that more is to be gained by accepting the opportunity of learning from others; the competitor usually already knows all about the 'secret' process. Dr. Maddocks referred to the high proportion of trained metallurgists who are being taken into the Armed Services, when industry requires them so urgently, and pressed that something should be done to remedy the position. Prof. Moore emphasized the need for 'putting over' the results of research; he rates it the major part of the problem. Finally, Mr. O. S. Brown, of the Department of Scientific and Industrial Research, outlined the many ways in which the Department is assisting in these matters. Thus help is always available for research in universities for "work of timeliness and promise". An information service has been set up to bring together the man with the problem and the man who can supply the solution. The aims are to create an organisation which is flexible and able to meet the varying needs of industry, to look for the gaps in the organisation and to consider how they can be filled.

In his summing up of the discussion, Sir Charles Goodeve hoped that the Federation would stimulate the examination of the questions discussed. Co-operative action, he said, is clearly called for, as well as more exertion. Much depends upon the technical knowledge of those in executive positions, since they must have sound discrimination in making their important decisions. The small firms may be facing a challenge greater than they have to-day. They should seek knowledge, cultivate a 'divine discontent' and have courage. They might not then long remain small.

HARDENABILITY OF STEEL

In the spring of 1943 a small mission of British metallurgists visited the United States and Canada to discuss the extent to which economy in the use of alloys required for the production of certain special steels could be still further increased. The problem arose from the fact that some of the alloying metals in common use in peace-time were not then available in quantity sufficient to meet the whole of the requirements of the Allies, and alternative steels had to be devised. A most comprehensive account of some of the work done in this direction is included in a "Symposium on the Hardenability of Steel" published by the Iron and Steel Institute, and discussed at a meeting of that Institute on May 14. It should be pointed out—a fact which was not always remembered during the actual discussion—that this work was done under the stress of war-time conditions and that, therefore, there are numerous problems which still await more detailed examination. Fundamental questions of the greatest interest have emerged, and many fields for further work opened up.

The major portion of the papers deal with the end-quench hardenability test—usually known by the name of the 'Jominy test'—the interpretation of the results obtained, and the possibility of using these to predict the extent to which bars of different diameter can be hardened. The influence of boron in increasing hardenability, and, therefore, its potential value in the reduction of the amount of other alloying elements required, is another problem to which attention has been given.

The Jominy test itself has received careful scrutiny, and a most valuable standard procedure for carrying out such investigations drawn up. It must be realized immediately that, in this test, hardness measurements alone are made, and other mechanical properties, therefore, are not taken into consideration. It is well known, however, that these properties, the notched-bar test for example, may vary to a very considerable extent, even with the same steel, and in a condition of identical hardness; the 'temper-brittleness' of some nickel-chrome steels affords an excellent example of this fact. It is clear, then, that while the intelligent use of the end-quench hardenability test may be of great value in providing a preliminary classification of different types of steel, it is equally important to realize that it does not obviate the necessity for other tests where ductility and toughness are of importance.

In view of the 400 pages of papers submitted, the Committee has done well to publish an agreed statement of the principal conclusions reached.

In connexion with the reproducibility of the curves obtained from the Jominy test, it is concluded that the end-quench test is capable of yielding satisfactorily reproducible results provided that the material under test is homogeneous, and that these results are not appreciably affected by small changes in the conditions under which the test is carried out. The end-quench curves determined on different samples of the same ingot, whether forged or rolled to approximately the diameter of the specimen, generally show only small differences. Further, the curves determined on samples from different ingots of the same cast of steel also in general show only minor variations. A marked variation of hardenability may, however, exist across the section even of a single bar, and in general, though not invariably, the hardenability at the centre is less than that at the surface. The hardenability of a steel may also be slightly affected by a variation of the microstructure before quenching. An examination of the hardenability of a hyper-eutectoid chromium–molybdenum steel, for example, suggests that the amount and distribution of the free carbide has a significant effect.

In connexion with the relationship of hardenability and chemical composition, the Committee reports that a wide variation in end-quench hardenability may exist between different casts of steel produced to the same specification, and that even when the variation of composition is taken into account, the hardenability cannot always be calculated satisfactorily from a knowledge of this and the grain size. Dealing with the prediction of the hardness of quenched, and quenched and tempered, bars from hardenability curves, it is concluded that the hardness curves of an oil-quenched bar across its diameter cannot be derived consistently and with adequate accuracy from a single end-quench curve, but that the hardness of a quenched and tempered bar may be predicted satisfactorily from a test specimen which has been end-quenched and afterwards tempered. The combination of mechanical properties obtained from steel that has been quenched and then tempered in the range 500°–650° C. depends on the hardness developed by quenching; but there are as yet serious difficulties in interpreting end-quench curves in terms of the ability of steels to attain any required combination of mechanical properties. Further, the transformation-temperature ranges of steels during continuous cooling can be determined approximately from a series of interrupted end-quench tests.

The Committee, at first under the chairmanship of the late Dr. T. Swindon, and later under that of Mr. D. A. Oliver, has done an admirable piece of work. Where all are so good, it is invidious to pick out any one contribution, but the writer may, perhaps, be allowed to mention his own special interest in Mr. T. F. Russell's theoretical treatment of the Jominy test.

Throughout this work the fullest acknowledgment is made to the previous researches of Grossman, Jominy and their collaborators. Further, Crofts and Lamont of the Union Carbide & Carbon Research Laboratories, Niagara Falls, have delayed publication of their other early and extensive researches for inclusion in this publication.

Some idea of the scope of the interest shown in recent years is provided by a bibliography of 255 papers, all published between 1938 and 1944.

F. C. T.

SOCIAL VALUE OF WAR-TIME MEDICAL RESEARCH

SIR ALEXANDER BIGGAM has published a valuable paper on "War-time Advances in Medicine which might be translated into Civil Practice" (*Edin. Med. J.*, 53, 413; Aug. 1946). In a world war, he says, some medical problems become so important that solutions of them must be found at all costs and, during the Second World War, the attacks upon these problems led to important advances in our knowledge, especially in the practice of preventive medicine.

One of the greatest enemies of the Allied Forces overseas was malaria. It could be argued, in fact, that malaria was our greatest enemy, and it is still the most formidable of the epidemic diseases which attack man. Sir Alexander states that it caused, in Burma at the beginning of the recent war there, nearly half the total sickness experienced. Intensive research on methods of control was therefore imperative, and an enormous amount of research was done. It was greatly helped by volunteers who included members of the Friends Ambulance Unit, students at the University of Oxford, where the Army Malaria Research Unit was situated, and soldiers serving at the Army Medical College. Much research was done elsewhere, and notes upon it have appeared from time to time in *Nature*. The advent of D.D.T., which kills the mosquitoes, and of dimethyl phthalate and other repellents, and of mepacrine, paludrine and the latest addition to our antimalarial drugs, *SN* 13276, have enormously increased our control of malaria. Sir Alexander tells us how these weapons were used in the Far East. His account may be compared with the fascinating story of the eradication of *Anopheles gambiae* from Brazil by a team working for the Brazilian Government and the Rockefeller Foundation (see *Nature*, 153, 765; 1944), a remarkable feat which has been repeated by the same workers in Egypt, where, in the Nile Valley in Upper Egypt in 1943, some 130,000 people died of malaria transmitted by this species of mosquito (see Rockefeller Foundation Report, 1946). A valuable account of the principles and methods of malaria control has also been given by Dr. G. Macdonald, director of the Ross Institute, in his "Notes on Malaria and its Control for Planters and Miners" (April 1946), a pamphlet which discusses, in addition to the principles and methods of control, the malarial parasite itself, its main carriers in the British Empire, the types of land associated with malaria in Malaya and the factors which affect the incidence of malaria.

Another major menace of the Allied Forces in the East was bacillary dysentery. In the British Forces this was treated with sulphaguanidine, but the United States medical men preferred sulphadiazine, which was, they claimed, more effective. Sulphaguanidine, however, is less likely to affect the kidney, and British opinion, therefore, considered that it was preferable in tropical countries where much fluid is lost by sweating and where the sufferer is often dehydrated. Sir Alexander discusses the use of sulphaguanidine, and also the use of D.D.T. against the flies which spread the organisms which cause bacillary dysentery.

Serious also was amœbic dysentery, and much experience of its control and treatment was gained. Sir Alexander especially mentions the cases which resist treatment; and the view that they do so because secondary pyogenic organisms, which infect the intestinal walls already damaged by *Entamœba histolytica*, render these cases intractable. He quotes the work of W. H. Hargreaves (*Lancet*, ii, 68; 1942), which indicates that a preliminary treatment with penicillin and a sulphonamide drug would remove these secondary organisms, so that the attack upon *E. histolytica* with specific drugs such as emetine bismuth iodide, chiniofon, etc., then produces good results. Sir Alexander outlines the treatment which should be given.

Epidemic typhus was not a serious risk in Burma. Mite-typhus (scrub-typhus) was one of the greatest problems encountered in that country. The control of this disease, which is caused by *Rickettsia orientalis* and is transmitted by the larvæ of the mite *Trombidium akamushi* and perhaps by other species of this genus (see *Nature*, **157**, 236; 1946), was helped by attacks upon the mite with dimethyl phthalate. The remarkable story of the mass production of the vaccine against this disease has been told by Fulton, F., and Joyner, L. (*Lancet*, Dec. 8, 1945, p. 729, and Buckland, F. E., *et al.*, *ibid.*, Dec. 8, 1945, p. 734. See also the *Lancet*, Sept. 8, 1945, p. 308). So serious was the menace of the disease that the production of this vaccine was given the highest priority. Special laboratories were rapidly erected, cotton rats, in the lungs of which the *Rickettsia* develops abundantly, were flown from the United States by the R.A.F., and the devoted work of volunteers, who took very considerable risks of severe illness or death during their work (the accidental infection of four of these workers is described by Van den Ende, M., *et al.* (*Lancet*, July 6, 1946, p. 4)), produced enough of the vaccine to inoculate a considerable number of troops in Burma. The collapse of Japan and the withdrawal of Allied troops from the areas in which the disease was prevalent have made it unlikely that the results of this mass inoculation will now give useful information; but research on the vaccine has not ceased.

The rest of Sir Alexander's article is devoted to notes on typhoid fever, only a few outbreaks of which occurred, to warnings about the use of sulphonamides in the tropics where excessive sweating increases the risk of damage by these drugs to the kidney, to penicillin and to laboratory methods of the diagnosis of smallpox and other diseases. There are interesting notes on the importance of preventing sea-sickness in troops about to cross rough seas. Research done by the Medical Research Council in co-operation with military medical men showed that the most useful remedy for it was 1/100 grain of hyoscine given one hour before embarking and repeated every six hours. If the dose has to be continued over a long period, it must be reduced.

In his note on the work of psychiatrists, Sir Alexander says that the successful placing of men, selected by psychological tests, was one of the successes of the recent war. Important also were centres for physical development. A final note on administration points out that medical personnel in an Army Medical Service are under complete administrative control, so that a study of this Service and of the results obtained by it is especially interesting now that a State medical service is to be introduced in Great Britain.

G. Lapage

THE IRISH PILCHARD FISHERY

The fishery for pilchards (*Sardina pilchardus*, Wal.) off the coasts of Cornwall has been famous for many centuries, and also the French, Spanish and Portuguese fisheries for sardines, which are the same species of fish. It is not generally known, however, that there has been also, at various periods, a flourishing Irish pilchard fishery. The appearance of a detailed historical account of the Irish pilchard fishery is therefore particularly welcome as being at once interesting and instructive*.

An Irish pilchard fishery existed so far back as 1591 and probably earlier; but its activities can be traced with some degree of accuracy only from about the year 1611. This is done comprehensively and in detail in the body of the paper, and is admirably summarized at the end.

The records show that the pilchard, when it frequents Irish waters, does so mainly along the coasts of Waterford, Cork and Kerry, although it is by no means confined to those counties. But the fishery has always exhibited extreme fluctuations, and, in recent times, the pilchard appears to have forsaken Irish waters almost entirely from 1904 until 1935. In the latter year shoals began to reappear, and in 1940 pilchards were plentiful once more off Ireland.

Unfortunately, there appears to be no demand in Ireland now for this fish, either fresh or preserved, and a vast potential source of food is not being exploited. But pilchards are occasionally caught when herring and mackerel are being fished, and even then they are usually thrown back into the sea. Nevertheless, the day yet may come when pilchards will command a ready market, even in Ireland, and this record of what the author calls "pilchard years" will then be invaluable. In the meantime, his paper is an outstanding contribution to our knowledge of this fishery over a very long period, and one hopes that its appearance will stimulate someone in a position to do so to prepare a similar historical account of the Cornish pilchard fishery.

G. A. Steven

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* *Proc. Roy. Irish Acad.*, 51, B, No. 5. Pp. 81–120. The Irish Pilchard Fishery. By Arthur E. J. Went. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, 1946.) 2*s.* 6*d.*

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 23

University College, London (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Kapp : "The Presentation of Technical Information", Second Series, 4 : "Some Specific Problems".*

Wednesday, June 25

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

Thursday, June 26

Physical Society, Acoustics Group (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 10 a.m.—Summer Symposium on "Sound Absorption and Reverberation".

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1), at 2.30 p.m.—Mr. F. Fancutt : "The Effect of Different Methods of Pretreating Iron and Steel before Painting" ; Mr. J. C. Judson and Mr. T. A. Banfield : "The Protection of Iron and Steel by Metallic Coatings".

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. M. Born, F.R.S., and Mr. H. S. Green : "A Kinetic Theory of Liquids", Parts 1–4.

Mineralogical Society (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Friday, June 27

Physical Society (in the Physics Department, Imperial College of Science, South Kensington, London, S.W.7), at 5.15 p.m.—D. J. Morgan : "A Model representing the Action of a Full-wave Rectifier" (demonstration) ; Prof. S. Tolansky : "Applications of Multiple-Beam Interferometry to Surfaces of Thin Films".

Saturday, June 28

Society for Endocrinology (in the Physiology Lecture Theatre, Guy's Hospital Medical School, London, S.E.1), at 10 a.m.—Symposium on "The Assay of Urinary Steroids".

British Psychological Society (at Bedford College for Women, Regent's Park, London, N.W.1), at 2.30 p.m.—Mr. Sydney Crown : "The Use of a Controlled Association Test as a Measure of Neuroticism" ; Mr. E. A. Peel : "A Method for Analysing Value Judgments and Preferences".

Monday, June 23—Saturday, June 28

British Grassland Society and the British Society of Animal Production (at University College, Aberystwyth).—Joint Summer Meeting.

Friday, June 27—Saturday, June 28

Clarendon Laboratory, Oxford.—Conference on "Liquid Helium".

Friday, June 27

At 2.30 p.m.—Opening of the Conference by Dr. K. Mendelssohn.

Saturday, June 28

At 9.30 a.m.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Assistant Mycologist in the Plant Pathology Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 28).

Senior Technician (Grade A, male), and Technicians (2, Grade B, male), in the Biochemistry Department, a Laboratory Technician (Grade A) with a good knowledge of photography, and a Senior Technician (Grade A) for the Physiology Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (June 28).

Lecturer in Mechanical and Workshop Engineering at the County Technical College—The Director of Education (Dept. F.E.), County Education Offices, Stafford (June 28).

Responsible Teacher of Engineering, and a Teacher of Mechanical and Production Engineering Subjects, in the Secondary (Technical) School and part-time Senior Classes of the Batley Technical College and School of Art and Crafts—The Acting Divisional Education Officer, Education Offices, Batley, Yorks (June 28).

Cereal Research Officer, Department of Agriculture, Western Australia—The Agent-General for Western Australia, Savoy House, 115 Strand, London, W.C.2 (June 30).

Assistant Masters in H.M. Dockyard Schools—The Director, Education Department, Admiralty, London, S.W.1 (June 30).

Junior Lecturer, and an Assistant, in Medical Statistics—The Secretary, The University, Edinburgh (June 30).

Speech Therapist—The Clerk of the County Council, County Hall, Newport, Isle of Wight (June 30).

Lecturer or Assistant Lecturer in the Department of Biochemistry—The Registrar, The University, Liverpool (July 1).

Senior Lecturer in Agriculture and Bookkeeping, an Assistant Lecturer in Agriculture, a Junior Assistant Lecturer in Agriculture, and a Junior Assistant in the Poultry School, Auchincruive—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (July 5).

Lecturer in Biochemistry—The Registrar, The University, Leeds 2 (July 7).

Lecturer in Zoology, an Assistant Lecturer in Zoology, a Lecturer in Biochemistry, and a Lecturer in Physiology—The Registrar, The University, Leeds 2 (July 7).

Senior Cyto-geneticist at Shambat, near Khartoum—The Secretary, Empire Cotton Growing Corporation, 1a Harrington Road, London, S.W.7 (July 12).

Research Physicist—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting A.158/47A (July 12).

Senior Lecturer in Physical Chemistry in the Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 15).

Lecturer in Civil Engineering in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 16).

Regional Fuel Engineers, male (London and provinces)—The Director of Establishments, Ministry of Fuel and Power, 7 Millbank, London, S.W.1, quoting 'Regional Fuel Engineer' (July 21).

Second Assistant to the City Analyst—The Secretary and Registrar, The University, Bristol, endorsed 'Second Assistant Analyst' (July 21).

Lecturer in Mathematics in the Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Professor of Dairy Husbandry in Massey Agricultural College, Palmerston North, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 1).

Scientific Assistant—The Director, Imperial Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire.

Botanist to undertake research on problems relating to the cultivation of *Hevea brasiliensis*—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7.

Workshop Technician, and Senior Laboratory Assistants (2, men or women), in the Department of Chemistry ; a Laboratory Steward (man or woman), and a Departmental Assistant (woman) interested in museum and herbarium work, in the Department of Botany ; and a Laboratory Technician, in the Department of Geology—The Registrar, University College, Nottingham.

Lecturer, and a Senior Assistant, in the Physics Department—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Lecturers (2) in the Department of Pure and Applied Science (one should be qualified to teach Elementary Metallurgy, the other should be qualified in Physics)—The Registrar, Loughborough College, Loughborough.

Lecturer in Chemistry—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Lecturer in the Electrical Engineering Department—The Secretary, Royal Technical College, Glasgow.

Lecturer in Chemistry, a Lecturer in Biology, a Lecturer in General Engineering Subjects, a Lecturer in Pharmacognosy, and a Senior Assistant in Mathematics—The Registrar, Municipal College, Portsmouth.

Assistant for abstracting, reviewing and indexing literature on forestry and forest products—The Director, Imperial Forestry Bureau, Oxford.

Lecturer in Electronics—The Head of the Electrical Engineering Department, Imperial College, South Kensington, London, S.W.7.

Lecturers in Mathematics (one in Grade II and two in Grade III), and a Lecturer (Grade III) in Physics—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

Lecturer, and an Assistant Lecturer, in the Department of Zoology—The Secretary, University College, Gower Street, London, W.C.1.

Graduate in Engineering Subjects with special qualifications in thermodynamics—The Principal, Erith Technical College, Erith Road, Belvedere, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Smithsonian Miscellaneous Collections. Vol. 106, No. 14 : A New Dussumieriid Fish of the Genus Jenkinsia from Bermuda. By Luis Rene Rivas. (Publication 3859.) Pp. ii + 4 + 1 plate. (Washington, D.C. : Smithsonian Institution, 1946.) [91

U.S. Department of Agriculture. Picture Sheet No. 15 : Boll Weevil. Pp. 2. 5 cents. Picture Sheet No. 16 : Bollworm. Pp. 2. 5 cents. Picture Sheet No. 17 : Cotton Aphid. Pp. 2. 5 cents. Picture Sheet No. 18 : Cotton Flea Hopper. Pp. 2. 5 cents. Picture Sheet No. 19 : Cotton Leafworm. Pp. 2. 5 cents. Picture Sheet No. 20 : Red Spider. Pp. 2. 5 cents. (Washington, D.C. : Government Printing Office, 1946.) [91

Television : a Bibliography of Technical Papers by RCA Authors, 1929-1946. Pp. ii + 10. (Princeton, N.J. : Radio Corporation of America, 1946.) [91

League of Nations : Economic, Financial and Transit Department. Food, Famine and Relief, 1940-1946. (II. Economic and Financial, 1946. II. A. 5.) Pp. iv + 162. 6s. net. The Population of the Soviet Union : History and Prospects. By Frank Lorimer. (II. Economic and Financial, 1946. II. A. 3.) Pp xiv + 294. 15s. net. (Geneva : League of Nations ; London : George Allen and Unwin, Ltd., 1946.) [91

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EDUCATION FOR LIVING

THE Central Advisory Council for England was appointed by the Minister of Education under Section 4 of the Education Act, 1944, in December of that year. By the terms of the Education Act it was decreed that "there shall be two Central Advisory Councils for Education, one for England and the other for Wales and Monmouthshire, and it shall be the duty of these Councils to advise the Minister upon such matters connected with educational theory and practice as they think fit, and upon any question referred to them by him. . . ." By agreement with Mr. R. A. Butler, who was Minister of Education in December 1944 and in the early months of 1945, the Central Advisory Council for England decided, as its first task, to examine the content and methods of education in those schools from which "the actual transition from life at school to independent life" is made; and the results of this preliminary inquiry have recently been published in the book entitled "School to Life".*

Since one of the most important and urgent tasks of educationists is to combine fixity of aim with diversity in application, the inescapable question is how general or liberal, as distinct from specialist or vocational, education can be so adapted to differing abilities and aptitudes that, while appealing deeply to each, it can remain in goal and essential outlook the same for all. The larger part of the question is how general education can be so adapted for the great majority, who are possessed of a lower facility with ideas than the intellectually gifted minority, that it can implant the power of thought and expression, the sense of relevance and value. It is, indeed, easy enough to postulate that, if general education is to be adapted to meet the needs of young people with differing abilities and aptitudes, it must make increasing use of what appeals directly to the senses. But merely to make this adjustment will not alone suffice. Those whom ideas leave unmoved must come to know them in more specific forms—mathematics when it is related to some mechanical task, history when it touches some trade, and design when it is wedded to some manufacturing process. Or, again, although some learn of democracy and of its privileges and responsibilities by growing familiar with ideas, all—and more especially the less intellectually gifted—learn also through action and by example; and, for those who see life primarily as action, the adaptation of general education must be such that they are roused to a realization of the connexion between ideas and day-to-day action.

Whatever detailed criticisms there may be of "School to Life", it will be generally agreed that the Central Advisory Council has done well to recognize the urgency of the need for this adaptation. In one striking passage in the report it is categorically declared: "The system is already established of transferring children for the post-primary years of school to some form of secondary school according to their different aptitudes. While the traditional curriculum and methods of the older endowed schools

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*H.M. Stationery Office. 2*s.* 6*d.*

may continue to meet the needs of many, the majority of children will be attending secondary schools which do not belong to this tradition. . . . Industry may well suggest something both of subject and method which will help rather than hinder their efforts."

It is, however, to be noted that, in citing examples of some of the ways in which the practical element can be introduced to general education at the secondary stage, the Council is insistent that "the danger to be avoided is that of subordinating the whole personality to a narrow conception of industry's need"; and not the least valuable feature of this report is, in consequence, an insistence on the distinction between general education with a technical bias and vocational training. Although the insistence on this distinction has led the Council to accept such questionable conclusions as "works schools are no substitute for county colleges" and "industry should provide its own special training", it has resulted in a balanced appreciation and criticism of education as "a preparation for a useful and satisfying life".

Even if, as has been suggested, the Council has misunderstood its function in addressing this report to a wider audience than was the practice of the Consultative Committee in framing the Hadow and Spens Reports, it has succeeded in focusing attention on the difficulties and uncertainties which have, in the past, needlessly attended "the transition from school to independent life". In endorsing the view, expressed fifty years ago by the Bryce Commission, that secondary education is technical because "it teaches the boy so to apply the principles he is learning, and so to learn the principles by applying them, or so to use the instruments he is being made to know, as to perform and produce something, interpret a literature or a science, make a picture or a book, practice a plastic or manual art, convince a jury or persuade a senate, translate or annotate an author, dye wool, weave cloth, design or construct a machine, navigate a ship, or command an army", the Council is saying nothing that is new. In emphasizing the further conclusion of the Bryce Commission that "technical education is secondary" to that part of education which, in the words of the report of the Harvard Committee on "General Education in a Free Society", looks first to the needs of a young person "as a responsible human being and citizen", it is underlining the most important—and the most neglected—conclusion of the Percy Committee. If there is to-day no need to argue that "the position of Great Britain as a leading industrial nation is being endangered by a failure to secure the fullest application of science to industry", it is, in present circumstances, still essential to subject to the most ruthless analysis the further conclusion that "this failure is partly due to deficiencies in education".

The deficiencies to which the Percy Committee referred are not to be explained solely—or, indeed, satisfactorily—by comparing the provision for technical and other forms of secondary education, or by deploring the number of university graduates in relation to the rest of the population. Those educationists and politicians who imagine that merely to increase the number of those who are given specialist education, whether at the secondary or the university level, is to safeguard the position of Great Britain as a leading industrial nation would do well to ponder the warning in a recent editorial comment of *The Economist* that "there are plenty of managers in this country who cannot manage, teachers who cannot teach; statisticians who cannot count, and women who cannot wash up. The country, in fact, abounds in incompetents. What, however, does not seem to be realized is that this incompetence is not due to lack of training, but reflects the failings of the country's educational system. The remedy is not to give a professional smear to a bad construction, but to secure what is so often overlooked—the training of minds."

The continued failure to appreciate this fundamental need has arisen, in part at least, from the widespread neglect of the dictum that "you may not divide the seamless coat of learning". In the weaving of it there are three strands—accurate knowledge, a wise competence, and a true valuation—and, until each is conceived as an essential and inseparable part of total education, whatever bias it may be given, so long will educationists fail to fulfil their primary responsibility. The true purpose of general education is not to teach the individual many things, or even much, but to afford him the opportunity to 'learn to think' and to 'learn to learn'. To those who realize that, because its purpose is not thus conceived by many who either legislate or teach, there is the further failure to appreciate that technical education can afford a unique opportunity to translate into practice the indivisibility of the educationist's responsibility, the insistence of the Central Advisory Council that "there is no objection on educational grounds to bringing into education anything [illegible] intrinsic interest by way of subject-matter [illegible] process that industry can provide" will be doul[illegible] welcome.

It would, however, be less than honest to suggest that the Council has, on the evidence afforded by "School to Life", fully appreciated the purpose of general education, as opposed to vocational training. Few, if any, educationists would quarrel with the conception of that "complete and generous education" which inspires and gives unity to the Education Act, 1944; but many would not be content, as are the members of the Council, to interpret their conception of a "complete and generous education" by reference to the opening words of the White Paper on "Educational Reconstruction": "The Government's purpose in putting forward the reforms described in this Paper is to secure for children a happier childhood and a better start in life; to ensure a fuller measure of education and opportunity for young people and to provide means for all of developing the various talents with which they are endowed and so enriching the inheritance of the country whose citizens they are". The fundamental weakness of this report—and it is one which largely invalidates the very real distinction which is drawn between general education and vocational training—is the insistence of the Council that the final test of the educated man or woman is the "quality of the individual life". To emphasize unduly the "quality of the individual life" is to ignore the relation of man to society, the concept of democracy as no less a spiritual ideal than a system of government, and the responsibility of private judgment which true democracy imposes on every member of a democratic society and which it is the task of general education to inculcate. Vocational training, by equipping young people for certain tasks, is avowedly competitive in spirit and looks to worldly success. To know how to do something is to have, or seem to have, a possible start in life; and on any view vocational competence is a requisite of worldly advancement. But no society—and certainly no democratic society—can be organised simply in the interests of the fittest and hope to survive. If it were, it would cease to be a political society in the sense in which Aristotle understood the term, requiring a common equipment, open equally to the enjoyment of all, and created by a common effort of co-operation. Ideally, the success of an individual is meaningless or harmful, except as it is the mark of his superior service to the common good; and general education, if its purpose and spirit are rightly conceived, should represent a force in the curriculum of the school, and ultimately in society, which is not in the main competitive.

Of the need for such an interpretation of general education there is to-day no question. While differing abilities and aptitudes appear to be inborn and to grow independently of background and environment, they would seem to be drawn forth or repressed by the spirit of the age; but general education, if it is conceived as an antidote to the competitiveness of contemporary life, could be an essential means of venting that narrowing of the potential gifts of individual which competition enforces. More itively, the acceptance of a common core of ining and knowledge, and its adaptation to meet he needs of differing abilities and aptitudes, could ensure that every young person, irrespective of his bents, learns to share "the common knowledge and the common values on which a free society depends". Even if there must be an academic bias in the education of some, a technical in that of others, and a modern (for lack of a better name) in that of the large majority, each could enter into that heritage of knowledge and values which is concerned to illumine the physical world, man's corporate life, and his inner visions and standards.

An ideal, but not impossible, vision of the democratic society of the future might see it composed of a myriad of smaller societies representing between them all the arts and insights of civilized man. It would be that they might participate in some of these, quite as much as for making a living, that education would prepare young people, and this participation would bring, in turn, that true "quality of the individual life" which is alone the test of the educated man or woman.

BACTERIAL STRUCTURE AND ACTIVITY

The Bacterial Cell

In its Relation to Problems of Virulence, Immunity and Chemotherapy. By Prof. Rene J. Dubos. (Harvard University Monographs in Medicine and Public Health.) Pp. xix + 460 + 22 plates. (Cambridge, Mass: Harvard University Press; London: Oxford University Press, 1946.) 28*s*. net.

IT has been thought that bacteria, with their comparatively simple morphology, are the most primitive forms of living things. It is only in recent years with the development of new techniques and the great advances that have been made, particularly in the field of bacterial physiology, and to a lesser extent in our knowledge of their structure, that their complex and diverse nature has been appreciated. This very diverse nature and the economic and medical importance connected with so many of the micro-organisms have resulted in bacteria being studied from many different angles. There has, in consequence, been a tendency for bacteriologists to remain limited to their own particular field. One of the outstanding values of this admirable book by Prof. Dubos is the co-ordination which he attempts between these various fields, so that one is enabled to view the bacterial cell and its multiple activities as a co-ordinated whole. It will go far to remove such obviously one-sided ideas as to regard the cell as a bag of enzymes or a mass of undifferentiated macromolecules. Dubos covers a wide field, and in the course of 460 pages cannot do more than give a bird's-eye view of the problems involved. Nevertheless, the bird is more of the nature of a lark than an eagle, and frequently comes down to earth to illustrate his points by specific examples. Indeed, there are more than a thousand references, although there is a tendency in the text to group these so that it is not always possible to trace the particular author of an observation cited.

Dubos starts by defining the problems he is up against. He stresses the impossibility of placing bacteria with any certainty into a phylogenetic scheme. His statement that "It is unlikely . . . that the distribution of metabolic characters can reveal the trends of physiological evolution and . . . any attempt to develop a phylogenetic system will have to be based . . . on what morphological characters are available" is open to question. The rather artificial phylogeny of Stanier and VanNiel which he appears to prefer is not very convincing.

Three chapters are devoted to the examination of the structure of the cell both directly, by staining and other microchemical and physical techniques, and indirectly by enzymes specific for various components of the cell, by immunology and bacteriophage action.

There is a natural transition from this to a chapter on bacterial variation. Here are discussed the normal variation occurring during the growth-cycle, adaptation and transmissible variation. In connexion with adaptive enzymes, the conclusion that their production "always involves synthesis of new protoplasm" although cellular division may be absent is no longer tenable in view of the recent work of Pollock and others, who showed that adaptation of both bacterial nitratase and tetrathionase may occur without increase in cell mass. In the case of transmissible variation involving environmental factors, Dubos inclines to the view that this is a selection of an existing mutant. He quotes the work of Lewis on the selection of an existing mutant in *Bact. coli mutabile* very fully, but omits to mention the classical paper of Luria and Delbruck, who by the application of mathematical analysis to their experimental results showed conclusively that bacteriophage-resistant mutants are not induced but merely selected by the bacterial virus. The evidence for life-cycles and sexual reproduction is examined, and the verdict 'not proven' made. The chapter concludes with an account of one of the most significant advances in this field, namely, the work of Avery and his colleagues on the role of desoxyribonucleic acid in the pneumococcus on the production of its specific capsular polysaccharide and the transmutation of one pneumococcal type into another by this substance derived from the latter. It is enormously active: $1/6 \times 10^8$ being sufficient to produce the change, which is transmitted indefinitely.

In the following chapter, the question of virulence is discussed very fully. Dubos points out the vast number of unrelated factors which are concerned in this problem, any one of which might vary independently of the others. Quite apart from the possession of specific soluble antigens, toxins and the like, which no doubt are important factors, there appears to be more deep-seated cellular factors. A rough form derived from a virulent smooth organism regains its virulence when reconverted to the smooth form even when this is effected by smooth vaccines from avirulent organisms. Conversely, a rough form of an avirulent smooth organism remains avirulent even when a smooth vaccine from a virulent strain is used in the conversion to the smooth form. In the transmutation of pneumococcal types by the Avery technique the virulence of the new type depends on the virulence of the initial type from which the 'competent' rough form has been acquired.

Having dealt with the general structure and biology of the microbe, Dubos turns his attention to methods of destroying bacteria or preventing their multiplication. In the chapter on immunization against infection, he traces the historical development of the science of immunity and then considers the antigens of the cell which are responsible for elucidating the protective antibodies. These are not only the type specific antigens, but, as in the case of factors determining virulence, there is evidence that deep-seated non-specific antigenic substances are also responsible. These are present in the *R* forms. One example, however, that he quotes, namely, immunization with avirulent *R* forms of *B. anthracis*, is not really an instance of this, since immunity depends on an extracellular antigen actively produced by the living organism in the tissues of the host and not on a deep-seated antigen already present in the organism.

From this he passes on to consider the mechanisms of protective immunity and factors determining the preparation and standardization of adequate vaccines.

A long chapter is devoted to bacteriostatic and bactericidal agents and their mode of action.

He points out that there has been a return to the specific receptor theory of Ehrlich in the Woods–Fildes hypothesis of "specific poisoning of an essential reaction excited through an interference with a catalyst or essential metabolite". Many examples of this are given. Nevertheless, non-specific physiochemical reactions also occur. He gives examples of such reactions in the formation of unionized complexes between dyes and the acidic or basic groups in the organism, and in the action of surface-active substances. Many of these reactions are not entirely non-specific as they depend on particular acid or basic groups present in the cell. Differences in this respect are found between Gram-positive and -negative organisms and even between species very similar to each other, for example, *Bact. coli* and *Salm. typhi*. He discusses next the question of reversibility and the difference between bacteriostatic and bactericidal agents. This depends on a large number of environmental factors. It is often a quantitative rather than a qualitative difference.

In an addendum, Robinow describes nuclear structures in bacteria. It includes many excellent photographs of bacteria stained by his special method to demonstrate the nuclear apparatus.

This book will certainly rank with Landsteiner's "Specificity of Serological Reactions" as a classic in bacteriological literature. G. P. G.

PAINTER AND WRITER

A Canvas to Cover

By Edward Seago. Pp. 134 + 68 plates. (London: Wm. Collins, Sons and Co., Ltd., 1947.) 15*s*. net.

PAINTER and writer, yes, in that order. One feels that Mr. Seago will agree because he has called his very attractive book "A Canvas to Cover" and not "Paper to Write On". In this way he indicates that the picture comes first, and that his membership is of the band of painters who write rather than of the writers who paint. Thus he may escape the fate of Carl Larsson, who polished his prose with loving care and hoped it would be his memorial, but whose countrymen, deciding otherwise, obstinately continued to prize his paintings more highly than his writings.

Mr. Seago is a painter in the English tradition. He admires Constable—"the supreme master of landscape painting in terms of atmosphere and light"—Gainsborough, Crome and Cotman. Turner is not so sympathetic: "Turner was a great master—he was a caged being trying desperately to free himself". These are the main influences on the painter. But what of the writer? He has read widely; his pages contain quotations from Shakespeare to Shelley and Rupert Brooke, from Leonardo da Vinci to Ruskin and Roger Fry, but none of these has influenced his style, and Ruskin, surely, would have disapproved of "distant snow laying in a valley" (p. 104). At the same time, it is Ruskin who is quoted the most frequently, and that is no bad thing. Admiration of Constable coupled with a liking for Ruskin forms an excellent background for a painter.

The titles of his chapters and the wealth of illustrations show that the author's main concern is with the problems of painting out-of-doors, and it soon becomes evident that he is a close and careful observer of Nature in all her moods. Neither does he neglect the smaller things. He has noticed the behaviour of caterpillars on the railings of Berkeley Square, but is thoroughly confused about water-spiders (p. 72), unless, indeed, he uses 'water-spider' as a vernacular name instead of 'pond-skater'.

There is much sound sense in the text, a refreshing absence of 'isms' and theories, and a curious echo of Tolstoy in the phrase, "more simple people, living nearer the earth, are more touched by the essence of Art". Art itself is defined as "the expression of the senses through the imagination, and the basis is truth", not beauty—"Beauty is certainly not Art". That, of course, is true enough if by beauty is meant merely the sum of those qualities which please the eye, but if beauty is given its philosophical content of wholeness, harmony and radiance, it immediately becomes the major part of art, and comprises the entire intellectual element.

But Mr. Seago is not concerned overmuch with philosophy, although certain of his difficulties can only be solved on that basis. His chief concern is with light, atmosphere and colour, and here he has much of interest and importance to impart. In his opinion grey is the most abundant colour in Nature, not green, and in Great Britain that is so. It is the dominant greyness of the atmosphere which harmonizes colour in Britain to a degree unequalled anywhere else, and which gives to our landscape a quality of serenity and repose lacking in more arid climates. The whole book is full of notes on colour; indeed, one of its strongest points is the way in which the painter's vision is translated into terms the layman can understand. If the artist cannot make us see with his eyes he has done his best to tell us what to look for with our own.

The plates are uneven, for the simple reason that not all the originals are suitable for reproduction in monochrome. As a general rule, swift sketches done with a heavily charged brush do not come out as well as pictures with more finish. Apart from all other considerations, the impasto of the sketch is often a disturbing factor; examples are the spotty, 'pimple-faced' appearance of "White Sails" (facing p. 92), and the fussiness of "Sunlit Spire" (facing p. 113). It would have been better to have reduced the number of photographs to a half or even a quarter, and to have given four more coloured plates in their place. To do so would have added still further to the value of this interesting and stimulating book.

A. TINDELL HOPWOOD

PHILOSOPHY IN ACTION

Power and Events

An Essay on Dynamics in Philosophy. By Andrew Paul Ushenko. Pp. xxiii+301. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 30*s*. net.

IT is becoming clear that, among its other characteristics, the present intellectual barometer, especially in the United States, is set for 'change' rather than for 'fair'. Supercharged clouds are racing across the horizon, and it would not, one imagines, take a great deal to bring the whole thing down in a deluge. The mental image produced by this book is of that kind. A storm is a grand sight, and the pages before us contain grand thoughts. Of that there can be no doubt; and what they have to say is something like this. Classical philosophy was static in ideal and timeless in form. We call it 'taking long views'. The breakaway to a species of romanticism, mixed with more than a trace of the empirical, has produced a clarion call for progress, movement and intuition, with short shrift for analysis. Briefly, then, 'short views', or relatively so.

Dr. Ushenko attempts a reconciliation between these extremes by reviving Aristotle's *potentiality-actuality* as *power-event*. Naturally, there are significant differences, as when the author presents a respectable demonstration that power is an observable entity. Moreover, he adopts the wholly admirable principle of looking for a species of invariant, which might form the desired sheet anchor in transformations from one *Weltanschauung* to another. In this appears the possibility of a metaphilosophic system alongside contemporary work in metalogic and metamathematics. All well and good: what is surprising and encouraging is the setting selected for one of the major manifestations of power. This is none other than art, and the visual arts in particular. Indeed, it may be said that the transition from a typical Italian primitive painting, through the rhythm of the High Renaissance, to the romanticism of the Baroque, demonstrates very accurately corresponding events in the region of pure thought.

Several famous pictures are therefore discussed in terms of vector properties, namely, the capacity of implicit lines to carry over the eye to some essential point of the composition, and thus to generate æsthetic tension. That this is a very real effect was recognized years ago by Birkhoff in his "Aesthetic Measure". It is also amenable to qualitative analysis on a *Gestalt* basis, as I have shown myself in another connexion. A beautiful example given by Ushenko is Leonardo da Vinci's "Last Supper", though what can be learnt from it is perhaps not quite what the present author imagines. He quotes Wölfflin to the effect that the sensation of power is produced by the deliberate use of too short a table, and consequent crowding of the figures. Actually it is more likely that this feeling is caused by the step-wise grouping (not necessarily crowding) of the apostles about an axis passing through the Central Figure, and the 'reflexion' back to the middle suggested by the horizontality of the arms on the extreme right. But above all is Leonardo's choice of the moment of betrayal rather than the conventional one of Communion, as the theme of this sublime fresco. It connotes not peace, but a sword. All this reinforces the general argument in favour of *Sturm und Drang*, or at least a condition of dynamic equilibrium, such as Kekulé once invoked to establish the permanence of his benzene ring.

Thus it is that in the whole section dealing with power the author seems to be at his best. This is his own domain in which he is thoroughly at home. Outside, he discourses upon paradoxes, intuition, probability and so forth. The result here is less striking, and it might be prudent to regard these passages more as valuable comment than as new material. Apparently it is hoped that students will use the book as a text. If they do, they will need some kind of summary at the end of each main chapter (four in all), not as a temptation to skip the rest, but because a novice could not reasonably be expected to have a steady enough hand (and possibly head) to decant the liquor without undue spillage.

The general format is excellent, and the volume is a pleasure to handle. A minor blemish occurs in Fig. 1 (after Köhler). The segmental boundaries are drawn as dotted lines, whereas in the original (English edition) they are solid. The latter is much to be preferred for the fixation test.

To return to where we started. Dr. Ushenko's *Dynamik* is apt to run hot occasionally, and his reactions are a trifle gregarious. No harm whatever, though some of us may conceivably cherish something a little more *intime*, like a certain author of last century who honoured his thoughts by calling them the "companions of my solitude".

F. IAN G. RAWLINS

The Earth and the Stars

By Dr. C. G. Abbot. Pp. xii+288+29 plates. (New York: D. Van Nostrand Co., Inc., 1946.) 3.75 dollars.

THERE are many good books on astronomy intended for the general reader. This book cannot be included among them. It is a revision of a book, bearing the same title, which was published in 1925. But the revision has not been made with due care, and there are numerous errors and inaccuracies. The book is presumably intended primarily for American readers; but this does not justify credit for stellar parallax determinations being given only to American observatories, and the important contributions of the Greenwich and Cape Observatories ignored. The value for the solar parallax, derived from the observations of Eros at the opposition of 1931, is given wrongly. The parallax of Nova Persei 1901 is incorrectly stated; it is the value derived by a method which, as has been often pointed out, is invalid. The only determination of the constant of aberration which is mentioned is an old determination by Doolittle; there are many more recent and more accurate determinations. In view of the identification by Edlén of the origin of the coronal lines, the statement that the green coronal line is assigned to some ionized state of some common element could be improved upon. It is twice mentioned in the same chapter that Harlow Shapley has suggested a total of two hundred billion stars in our own galaxy. The sentence, "total eclipses of the Sun may occur in any month of the year", may be easily misinterpreted by the reader. In discussing the broadening of lines in stellar spectra no mention is made of rotational broadening. There is no continuity of plan in the book, which is scrappy and discursive. The publisher's note describes the book as "the absorbing story of the enigma of the universe: of the stars and constellations and their relationship to the earth". This seems to be a singularly inaccurate description of a book which is not worthy of its author.

La conquête de l'énergie atomique

1: Des Rayons uraniques à la Scission de l'Uranium (1896–1940); 2: De la Scission de l'Uranium à la Bombe atomique (1940–1945). Par Gerard de Vaucouleurs. (Actualités scientifiques et industrielles, 1000.) Pp. 114. (Paris: Hermann et Cie., 1946.) 120 francs.

OF the millions of words that have been written about nuclear energy, almost all are in highly technical (and mostly still secret) reports, or in articles and booklets that seek to explain the mysteries of nuclear physics and 'atom' bombs to the world and his wife.

M. de Vaucouleurs has chosen a middle path; he claims, in his preface, the distinction of not being a specialist in the field of which he writes, and he explains that his little book grew out of an article originally published by the French and Belgian astronomical societies. He has written, in scientific but non-specialist language, a sober but interesting account of the growth of nuclear physics from 1896 until 1940, followed by what is essentially a summary of the official American and British statements on the later developments that culminated in the explosions at Alamogordo, Hiroshima and Nagasaki. It can be read with ease and interest by anyone of scientific education, nuclear physicists included; no expert knowledge of French is needed, for M. de Vaucouleurs writes very clearly.

Names and dates are numerous, and with the aid of *Physics Abstracts* it is easy to locate the many published papers that the author has consulted. The reviewer applied his usual test of typographical accuracy by looking for the third 'c' in Prof. Cockcroft's name, and found it was not always there.

P. B. MOON

Faraday's Encyclopedia of Hydrocarbon Compounds

(Covering the Literature up to January 1st, 1946). Compiled by Dr. Joseph Escott Faraday. Vol. 3: C_8. Pp. cxii+457. (Manchester: Chemindex, Ltd., 1947.) £5 10*s*. 0*d*.

THE appearance of this volume means that the literature is now covered completely to January 1, 1946, for all hydrocarbons C_1–C_8, and by the end of next year it is hoped to publish addenda which will bring the whole work up to the end of 1947; the author has always kept his promises in the past and there is no reason for supposing he will not deliver the goods in the present instance. This will be no mean achievement.

The plan of the present volume must now be familiar to all organic chemists, as it is the same as that of the last; this is a proof, if one were needed, of the excellence of the original arrangement. The value of a compilation of this kind cannot be overrated. The necessity of searching Beilstein and the indexes of numerous volumes of *Chemical Abstracts*, etc., is obviated and all information, completely up to date, is contained in one place. The tedious and time-consuming literature search is a thing of the past, and would that a book such as this were available for all organic compounds and not only for hydrocarbons. Perhaps collaboration between the author and Dr. Dyson is indicated.

One improvement has been introduced: in the case of compounds where a large number of methods of formation are found—in the case of ethylbenzene, for example, there are 212—those that are likely to prove of use in the laboratory are clearly indicated.

The value of a book of this sort depends, of course, entirely on its accuracy, and although the reviewer does not claim a complete check, no errors were detected. The price of £5 10*s*. appears very reasonable for these times, and all chemical libraries should possess a copy.

Nature's Undiscovered Kingdom

By Walter J. C. Murray. Pp. x + 98 + 15 plates. (London: George Allen and Unwin, Ltd., 1947.) 7*s*. 6*d*. net.

THIS is a charming little book on the life of the countryside, from the wide landscape swept by wind and weather down to spiders in the herbage and moths fluttering through the twilight. A tendency to a somewhat "lyrical style" of writing (the words are borrowed from the publishers' note) is compensated for by accuracy of observation and description. The account, for example, of watching and photographing young grey squirrels is quite delightful. Mention of these squirrels reminds us that the illustrations are all from the author's own camera and deserve the fullest praise, in particular the portrait of a grey squirrel facing p. 23. Why the book was given the title of "Nature's Undiscovered Kingdom" eludes me, for this is certainly the kingdom into which Jefferies and Hudson pioneered many years ago: the author is a worthy follower.

F. PITT

THE TRANS-URANIUM ELEMENTS

By Prof. GLENN T. SEABORG and Prof. EMILIO SEGRÈ
University of California, Berkeley, California

BEFORE 1940, chemistry did not know of any element with atomic number greater than 92 (uranium). In spite of occasional claims to the contrary scattered throughout the literature, there still is no good evidence that such elements exist in Nature, except perhaps for minute amounts formed from uranium by neutrons of various origin. This finds its explanation in their instability, since their radioactive half-lives are now known to be small compared to geological times. The last seven years have seen the first positive identification of four trans-uranium elements, of atomic numbers 93, 94, 95 and 96, all discovered as a result of their synthesis by transmutation reactions starting with uranium as the primary material.

The first serious possibility for producing trans-uranium elements was opened by the discovery of artificial transmutation and artificial radioactivity, and particularly by the process of neutron capture found by Fermi and his colleagues in 1934[1]. The new isotopes formed by the capture of neutrons most frequently decay by negative beta-emission, to form elements with atomic numbers increased by one unit, and these workers asked themselves whether the bombardment of uranium should not lead to the element with atomic number 93. At the time they did not suspect the existence of the fission process, and hence they tried to interpret their observed complex of fission-product activities in terms of elements near uranium. The chemistry of the trans-uranium elements was, of course, not known; it was rather generally thought that they would be like rhenium, osmium, etc., the elements immediately above them in the same vertical column of the Periodic Table. Therefore, when their chemical tests showed that the induced activities were not due to elements of atomic numbers 86–92, these investigators naturally interpreted them in terms of several series of trans-uranium elements.

At this point the study of these substances was taken up by Hahn, Meitner and Strassmann[2], and for several years they interpreted their work on the trans-uranium assumption; but gradually difficulties piled up to the extent that this interpretation no longer seemed possible. Further study by these investigators[3] and by I. Curie and Savitch[4] showed that the trans-uranium hypothesis could not be considered satisfactory, since the number of distinct radioactive bodies became too large to fit simply into such a picture. The riddle of the many activities was finally solved by Hahn and Strassmann[5] in 1939 with the discovery of the fission process. Following this great discovery, many workers succeeded in identifying practically all the recognized activities as fission products. However, the important activity of 23-min. half-life, which had previously been assigned by Hahn, Meitner and Strassmann[6] to U^{239}, was confirmed to have been correctly assigned.

As the news of the discovery of fission spread rapidly over the world, many experimental investigations of this process were made. Of special importance to the subject of the trans-uranium elements were some measurements of the range of the fission fragments by the simple method of finding the distribution of fission-product activity in a set of thin foils placed in contact with neutron-irradiated uranium. This was done by many investigators, including Joliot[7] in Paris, Anderson and co-workers[8] in New York and McMillan[9] in Berkeley, California. A by-product of the latter investigation proved in the end to be more important than its original purpose, for in the thin layer of uranium oxide used was found a non-recoiling activity with a 2·3-day half-life, in addition to the expected 23-min. activity ascribed to U^{239}.

This 2·3-day body was immediately suspected to be the daughter of the 23-min. uranium, and hence was suspected to be the isotope 93^{239}. Experiments were made by Segrè[10] to test this genetic relation, but because of the ease with which element 93 exhibits some of the chemical properties of the rare earths, they were interpreted as meaning that the 2·3-day body was a rare-earth isotope.

Final clarity on the subject was brought about by the later work of McMillan and Abelson[11], in Berkeley, which led to their positive identification of a radioactive isotope of element 93, the first trans-uranium element to be discovered. They worked with pure samples of the 2·3-day activity, prepared by exposing thin layers of uranyl nitrate to neutrons from the 60-in. cyclotron and thus allowing the fission fragments to escape by recoil. By a series of chemical experiments they were able to show that the 2·3-day body has at least two oxidation states, the lower one showing chemical properties like the rare earths (and uranium IV and III) and the upper one behaving like uranium VI. They also demonstrated the growth of this body from the 23-min. U^{239}, thus establishing its identity as 93^{239}. Their results were later confirmed by Starke[12] and by Strassmann and Hahn[13] in Germany.

At this point it became obvious why element 93 had evaded earlier seekers, since its chemistry was more like that of uranium than that of rhenium, the most obvious difference from the former being the greater relative stability of the lower oxidation state or states. This similarity to uranium led McMillan and Abelson to suggest that a new series of elements of closely related properties was starting here, similar to the phenomenon which occurs earlier in the Periodic Table with the rare earths. Because of this relation, and the fact that uranium was named after the planet Uranus, McMillan proposed the name 'neptunium' for element 93 and 'plutonium' for its daughter element 94, which was, however, as yet unidentified.

The next step in the investigations at Berkeley was the identification of the element with atomic number 94. It was naturally supposed that 94^{239} would emit alpha-particles, but a search for them in decayed 93^{239} samples showed an activity too weak for good experimentation. Hence McMillan tried bombarding uranium with deuterons, hoping to produce another isotope of element 94 with a shorter half-life. This hope proved to be justified, and he found a definite alpha-activity, giving particles of a range near that of polonium. He was able to say in the summer of 1940 that the body responsible was not protactinium (element 91), uranium or neptunium, but had chemical properties resembling those of thorium (element 90). (This was shown by precipitation as the iodate using Ce (IV) as carrier.)

At this time a change in the nature of the investigation was taking place. The recognition by many people of the military possibilities of fission was having its effect, and the change to an organised programme under military secrecy was inevitable. McMillan was called away for research in the field of radar, and the work was continued at Berkeley by a group including Kennedy, Seaborg, Segrè and Wahl, at first as their own unsponsored research programme but later as part of the organised national war effort. During late 1940 and early 1941, the key to the chemistry of element 94 was found[14], using the isotope resulting from the deuteron bombardment of uranium, which was later shown to be largely 94^{238}. With a very strong oxidizing agent it was found possible to oxidize this element from the IV or III oxidation state to a higher state which is not precipitated as a fluoride, and thus to show that it was indeed a new element. These investigators adopted the name 'plutonium' for element 94, following McMillan's lead for naming trans-uranium elements after the planets beyond Uranus, and they suggested the chemical symbols 'Pu', for plutonium and 'Np' for neptunium. At about the same time, Pu^{239} was finally identified, and the military possibilities[15] of this isotope were established by the experiments of Kennedy, Seaborg, Segrè and Wahl[16], who measured the fission cross-section of Pu^{239} using a sample prepared by decay of Np^{239} and later further purified by taking advantage of the then known chemistry of plutonium. It is, of course, impossible within the scope of this article to describe the development of the chemistry, metallurgy and technology of plutonium from a tracer scale, through the ultra-microchemical or microgram scale and on up to the kilogram scale, and this phase of research and development has been dealt with partially elsewhere[17].

The investigation of the early chemistry of neptunium was limited to studies by the tracer technique using the short-lived isotope Np^{239}, as described above. Fortunately, there is another isotope of neptunium, Np^{237}, which is sufficiently long-lived to make it possible to work with weighable amounts using the methods of ordinary chemistry. This isotope is the decay product of the previously known 7-day beta-particle emitter U^{237}, which is formed[18,19] as the result of an $(n, 2n)$ reaction on U^{238}. This neptunium isotope, first observed, in Berkeley, by Wahl and Seaborg, is an alpha-emitter of very long half-life, $2{\cdot}25 \times 10^{6}$ years. Very fortunately, it is produced in the large uranium chain-reacting units in weighable amounts, so that the chemical properties of neptunium can be, and to a large extent have been, studied by the methods of ordinary chemistry and microchemistry.

More recently the next two trans-uranium elements, with atomic numbers 95 and 96, were discovered. During 1944 and 1945, Seaborg, R. A. James and A. Ghiorso, working at the Metallurgical Laboratory of the University of Chicago of the Manhattan District, identified in the products of the bombardment of Pu^{239} with 40 MeV. helium ions in the Berkeley cyclotron, two isotopes of element 96 of mass 240 and 242, that is, 96^{240} and 96^{242}, formed by (α, n) and $(\alpha, 3n)$ reactions. These isotopes are alpha-emitters with half-lives of one month and five months, respectively. At nearly the same time but somewhat later, Seaborg, James and L. O. Morgan at the same Laboratory identified an isotope of element 95 with mass 241. The 95^{241} is the daughter of a relatively long-lived beta-emitting Pu^{241}, and emits alpha-particles with a half-life of about 500 years. This work was made possible by the vital participation and co-operation of J. G. Hamilton and his group at the University of California, who had recently rebuilt the Berkeley 60-inch cyclotron to produce the required high-energy particles, and who performed the bombardments.

The chemical investigations on the tracer scale have shown that these 'trans-plutonium' elements are almost exclusively tripositive in aqueous solution. They behave chemically very similarly to the tripositive rare earths and can be separated, especially element 96, from the rare-earth elements only with difficulty, using fractionation methods. Apparently, stable tripositive element 96 contains seven *f* electrons with a structure analogous to stable tripositive gadolinium.

It is not possible, of course, to name elements 95 and 96 after planets beyond Pluto, since no such planets are known. These investigators have suggested the name 'americium', symbol 'Am', for element 95, and the name 'curium', symbol 'Cm', for element 96. These are suggested on the basis of the similarity with respect to *f* electrons of the electron structure of element 95 and the rare earth europium, and of element 96 and the rare earth gadolinium. Thus element 95 would be named after the Americas, or New World, by analogy with europium, which was named after Europe, and element 96 would be named after Pierre and Marie Curie, historical leading investigators in the field of radioactivity, by analogy with gadolinium which recalls Gadolin, the investigator of the rare earths.

There has been a great deal of speculation throughout the years as to the possibility of the existence in Nature of isotopes of the trans-uranium elements. The present state of knowledge of their chemical properties makes it possible to make efficient and meaningful searches for such elements. In fact, Seaborg and M. L. Perlman, early in 1942, made a chemical separation of neptunium and plutonium from a quantity of pitchblende ore, and were able to show the presence of a small quantity of alpha-activity in this trans-uranium fraction which they attributed to plutonium, the isotope Pu^{239}. The amount of plutonium in the pitchblende corresponded to about 1 part in 10^{14}, an amount which could not possibly have been found had the chemical properties not been known. This plutonium isotope is present in such uranium-containing ores, in spite of its relatively short half-life, probably because it is continuously formed by the absorption in U^{238} of some of the neutrons which are always present. A particular source of neutrons, sufficient in amount to account for the presence of this amount of plutonium, results from the spontaneous fission of uranium. It seems likely, in view of their relatively short half-lives, that the other trans-uranium elements could be present only as a result of a similar mechanism for formation, and hence will be present in such ores only at concentrations even smaller than that found for plutonium.

In conclusion, we wish to thank our colleague Prof. E. M. McMillan for supplying part of the material for this article and for helping in its preparation.

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THE ZOOLOGICAL SURVEY OF INDIA

By PROF. H. MUNRO FOX, F.R.S.
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THE Zoological Survey of India was founded in 1916. It derived from the Zoological Section of the Indian Museum. The latter was a descendant of the zoological portion of the Asiatic Society of Bengal. Annandale, a first-class naturalist and an authority on freshwater faunas, was the first director of the Survey. He had distinguished successors in Kemp, Sewell, and Prashad, and, when the last-named was lately called to be adviser on fisheries to the Government of India, in Dr. B. N. Chopra, the present acting director. Other members of the Survey who have achieved a high reputation are Dr. S. L. Hora, who for the past few years has been director of fisheries in the Province of Bengal, and Dr. H. S. Pruthi, recently selected to be director of the new Plant Pest Protection Bureau. From the beginning, however, the staff was small, and unhappily retrenchment in the early nineteen-thirties so much reduced it that the Survey was forced almost to abandon field work and to restrict itself to museum activities, thus cutting out its main purpose, namely, the animal survey of India. Indeed, the staff then became so small that even the proper care of the large and valuable collections became difficult.

The objects for which the Survey was founded were the following. First, it was to undertake faunistic studies so as to acquire all possible information on the geographical distribution of Indian animals; secondly, to maintain and add to the national zoological collections started nearly a century and a half ago by the Asiatic Society of Bengal; thirdly, to maintain and develop the public exhibits in the Indian Museum; fourthly, to identify specimens as required by investigators in any part of the country; and fifthly, to advise the Government on zoological matters. It is clear that the Survey has the functions of the British Museum (Natural History) in London with the obligations of the field survey in addition. This is an immense task in a country of the size of India.

In zoology, as in all the sciences, investigators will go on making discoveries for their own sake, from purely scientific curiosity. This is how fundamental science advances. Some of these discoveries are from time to time made use of for human benefit; no one can foretell which of them will be useful. The Zoological Survey of India functions in just this twofold way, and must continue to do so. Discoveries made by its staff in the field and in the laboratory may any of them be of inestimable value to India. This applies to medical zoology, which means animal pests and animals which transmit pests, to veterinary zoology, to agricultural science and forestry We may take one case a little more in detail, a case which is particularly important in view of the food shortage of to-day, namely, the fisheries. There is great need of developing and expanding the Indian fisheries, both marine and freshwater. More fish should be got out of the Indian seas, always taking care to avoid the danger of overfishing. Inland fishes could be more extensively and better grown in tanks. For all this, much knowledge is needed of the lives of the fishes. No doubt many of the necessary studies will be made in the universities, but the Survey must be the centralizing body, with its collections for the final precise identifications. It is seldom realized by non-biologists that all investigations must be based on the bedrock of accurate determination of the species of organism studied, and this is very much a specialist's responsibility. For development of the Indian fisheries there is also an urgent need for the establishment of at least one marine biological station, perhaps at Karachi where the fauna is good, and this should be closely linked to the Survey. It must be a research station such as that of Plymouth, with a permanent staff, adequate modern equipment, a research vessel, and a library.

In 1880 the Secretary of State for India commenced publication of the important series of monographs that bears the title of "The Fauna of British India". The early authors of these monographs were British, resident in India; for example, Dr. N. Annandale, Lieut.-Col. H. H. Godwin-Austen, Lieut.-Col. C. T. Bingham, W. T. Blandford, Lieut.-Col. Sir S. R. Christophers, Francis Day, Lieut.-Col. F. C. Frazer, G. F. Hampson, and Lieut.-Col. J. Stephenson. The first Indians to prepare monographs were S. Maulik, then professor of zoology in the University of Calcutta, and Dr. B. L. Bhatia; future volumes have been entrusted to Dr. Bhalerao, Dr. Chopra, Dr. Hora, Dr. Prashad and Dr. Sharif. With the introduction of self-government, the responsibility for the continuation of this series falls on the Government of India, and the editor of future volumes will be the director of the Zoological Survey of India: it is expected that many of the authors will be Indians, and the source to which one looks primarily for such experts is the Zoological Survey.

Last year Lieut.-Col. R. B. Seymour Sewell, formerly director of the Survey, returned to India at the invitation of the Government to submit proposals for the reconstruction and expansion of the Survey. His report was issued in November.

It is a document of great importance to the future of the Survey and of India. Sewell makes it clear that an enlarged Survey is essential to the scientific and economic advancement of the country. There should be a very considerable expansion of the staff. Originally there were four officers, then seven, now only five. There should be at least two dozen in the near future, so that each branch of the animal kingdom shall have its expert. One of the new officers would be naturalist to the Marine Survey. This would be a revival of the surgeon-naturalist's post, so fruitful in the past in the deep-sea work of R.I.M.S. *Investigator*.

The immediate difficulty will be to fill these zoological posts. Early this year I was in India as a delegate to the Indian Science Congress and then visited a number of the universities. Some of the zoology departments were excellent, others less good; but in most of them the standard could well be raised. In Indian universities zoology has not been so much developed as some of the other sciences. This is, no doubt, a matter of tradition, hard to change. In addition there are in India very few field naturalists. This means that first-class personnel for expanding the Survey will not easily be found. Sewell has put forward a scheme for the training of young Indian zoological graduates of the universities for two years in the Survey and then for a year abroad.

The Survey, with all its valuable collections and library, was moved for safety during the War from Calcutta to temporary quarters at Benares. There it is to-day, quite inadequately housed. There is insufficient room either to tend or to consult the collections, and the building is liable to floods which have already damaged valuable books. The Survey has the best zoological library in India, probably in Asia. Sewell recommends the erection at New Delhi of a new home for the Survey in a fire-proof, air-conditioned building. Here it would be placed centrally for Government consultation, situated near other scientific institutes.

When India assumes independence she cannot afford to neglect the expansion of her Zoological Survey.

NEW PHYSICO-CHEMICAL PHENOMENA IN THE DEFORMATION AND MECHANICAL TREATMENT OF SOLIDS*

By P. REHBINDER

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THE mechanical structural properties of solids—elasticity, plasticity and strength—are of paramount importance in most branches of modern engineering. These properties, which are determined by molecular interaction, are usually investigated without resorting to advanced physical chemistry. However, the methods of physico-chemical investigation of the deformation of solids, with due recourse to the factor of the chemical composition of the surrounding medium, lead to new methods of controlling the mechanical properties of solids and to novel methods of their mechanical treatment.

The earlier investigations by the author and his associates have established the fact that the addition to the surrounding medium of small amounts of the so-called surface-active substances, the particles of which are adsorbed on solid surfaces, is capable of considerably lowering the resistance of a solid to stress.

These very general phenomena of facilitating strain and disintegration of solids by adsorption have been extensively utilized by the author and his co-workers, and afterwards by many other investigators, both in the Soviet Union and abroad in various practical fields. For example, they have been used to facilitate the boring of stable (hard) rocks, in various processes of disintegration of solids by milling, in cutting and pressure working of metals, etc. It is this phenomenon of adsorptional promotion of strain that largely accounts for the effect of cooling lubricants, in the absence of which some of the above processes become altogether impracticable. The theory of this phenomenon must underlie any scientifically based selection of these lubricants.

During the Second World War, mainly in connexion with the application of these investigations to the machining of metals, we succeeded in elucidating to some extent the mechanism of the adsorptional promotion of strain and, at the same time, in discovering a number of new phenomena in this domain.

It was ascertained that these phenomena are associated with the penetration of surface-active substances into the depth of the strained solid along the surface of the wedge-shaped ultra-microscopic cracks which are developed in course of deformation. After unloading, that is, removal of the stress, the micro-cracks become closed again, the surface-active substances adsorbed on their inner surface are expelled by molecular cohesion and the original mechanical properties of the solid are restored.

The closing of the micro-cracks after unloading is a process involved not only in elastic but also in plastic deformations, with the sole difference that, after shear involving slippage, the closing of the cracks takes place at new points of their surfaces.

These investigations have led to the discovery of some new phenomena which have been described in the report referred to above, and partly demonstrated in a micro-cinematographic film. Special interest is presented by two effects resulting from the penetration of surface-active substances into the micro-cracks: the retarded elastic deformation in mica crystals and the structural changes on plastic deformation of metals.

When a sheet of mica is bent or stretched in absolutely dry air, the deformation occurs practically instantaneously as soon as the external force is applied, and disappears also instantaneously after removal of the stress when the latter is below the elastic limit. In the presence of moisture, however —in water vapour or when the crystal is wetted with water—a gradual increase of deformation on application of stress is observed and a gradual decrease on removal of the stress. On addition to the water of organic substances readily adsorbed on mica, for example, alcohols, this retardation is still further enhanced, and the time required for the deformation to attain its maximum or to disappear after unloading is a matter of some three days. Complete recovery is observed in the case of these phenomena.

So long ago as in the experiments of I. Obreimov on the cleaving of mica along the cleavage planes *in*

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* Summary of a report at a general meeting of the Academy of Sciences of the U.S.S.R. in July 1946.

vacuo, it was demonstrated that the cleft formed by introduction of a glass wedge is closed again on removal of the latter, so that subsequent cleavage requires almost the same amount of mechanical work. This phenomenon underlies the ingenious method suggested by I. Obreimov for measuring the surface tension at the cleavage faces of mica. The cleavage of mica in such experiments is quite similar to the formation of wedge-shaped micro-cracks, which, according to our concepts, are developed in the region of elastic deformations without any rupture of the solid. As has been kindly pointed out to us by Prof. I. Frenkel, such a concept of reversibly closing micro-cracks leads to the elimination of some grave flaws in Griffith's well-known theory and opens new ways towards its substantial improvement.

In studying the plastic flow in single crystals of the purest tin, it was established that under the action of the surface-active substances (for example, oleic acid or cetyl alcohol) added to the surrounding inert medium (purified paraffin oil), the number of the layers formed which slip over each other on extension of the single crystal increases fifteen-fold or more, whereas their thickness decreases in proportion. These phenomena were observed by means of accelerated micro-cinemaphotography of the stretched single crystals. The sorption of the organic surface-active substances by the strained metal lowers the yield value of tin to half the original value, facilitating the flow by a kind of 'internal' lubrication of the slip planes. Such sorption manifests itself in the abrupt fall of the electrical conductivity of tin, which on removal of the external stress is gradually restored as the original mechanical properties of the metal are restored.

In the case of ordinary, small-grained zinc and copper, the strain-hardening of the outer layers was found to increase sharply after periodic deformation in the presence of surface-active substances. The adsorptional lowering of the hardness of the metal originally observed on deformation is followed by its sharp increase due to a secondary phenomenon: strong disintegration of the crystal grains or their orientation (formation of texture), which always leads to hardening. Some new electrocapillary phenomena were also observed and investigated, namely, the lowering of the hardness or strength of metals in solutions of electrolytes when the surfaces of the micro-cracks formed are charged electrically, irrespective of the sign of charge.

The seat of the above peculiar surface phenomena is thus the inner surface of the micro-cracks which are developed in a strained solid. The latter is, as it were, a kind of labile adsorbent, the newly formed surface of which gradually disappears again after unloading. The whole set of phenomena of adsorptional promotion of deformation in a solid can be regarded as evidence in favour of our concepts regarding the continuous development of micro-cracks in the process of deformation, beginning from the region of elastic deformations.

The elucidation of these phenomena is evidence of the fruitful result of resorting to physical chemistry in the problems of physics and mechanics of solids. This boundary domain of science can in general be said to be of great practical importance in the solution of the problems involved in the working and machining of metals and other solids, as well as in the theory of wear, creep, corrosion, fatigue and a number of other problems in the applied physics of metals and building materials.

THE FIRST CHEMICAL JOURNAL

By Prof. JAMES KENDALL, F.R.S.

In connexion with the forthcoming centenary celebrations (postponed from 1941) of the Chemical Society, the discovery of the first volume of the proceedings of an older organisation in the same field is of timely interest.

This volume—a well-bound folio of 452 pages in copper-plate manuscript, inscribed simply "Chemical Society instituted in the beginning of the year 1785"—was presented to the Royal Irish Academy by Sir William Betham on January 26, 1846, and lay unnoticed in its library for more than a century. Recently, however, it attracted the attention of the Rev. P. J. McLaughlin, of St. Patrick's College, Maynooth, and through an article written by me in the July 1942 number of *Endeavour*, Dr. Farrington, librarian of the Academy, and Dr. McLaughlin were able to identify it as Volume 1 of the *Proceedings of the Chemical Society of the University of Edinburgh*. Practically all the thirty-two communications which it records *in extenso* represent, in fact, papers read at meetings of this Society by members whose names are on Joseph Black's "List of the Members of the Chemical Society, 1785".

That it should have found a resting-place in Dublin is not really surprising. The nationality of nineteen of the fifty-nine original members of the Edinburgh society has been definitely established; of these only three were native Scots, three English, and the residual thirteen were Irish! Presumably the unknown secretary, to whose admirable diligence the volume owes its existence, was one of this majority and retained possession of his handiwork on his return to Ireland.

At my request, the Council of the Royal Irish Academy agreed to send the volume on loan to the Royal Society of Edinburgh for my inspection. Unfortunately, the communications do not include anything of major scientific importance, and my expectation that the volume might afford a unique record of contemporary chemical thought has not been realized. I had hoped to find some lively discussions (with Joseph Black himself participating) on the revolution that Lavoisier was then leading against the phlogiston theory, but this is rarely even mentioned. Most of the papers are routine descriptive chemistry of the classical period, and the most promising of the few exceptions, "an attempt [by Mr. Thomas Beddoes, later director of the Pneumatic Institution and supervisor of Humphry Davy] to point out some of the consequences which flow from Mr. Cavendishes discovery of the component parts of water" peters out, after an attractive start, into an addendum entitled "a conjecture concerning the use of Manure"!

This disappointment, however, emboldened me to make a second request to the Council of the Royal Irish Academy, that it should present the volume to its original owners, and to that request it has now graciously consented. The oldest chemical society in the world will certainly treasure the first volume of its proceedings as a priceless possession. Even if it has no great intrinsic value, it does after all constitute the first journal extant of a purely chemical character, the *Annales de Chimie* being initiated just five years later; and extracts from it may well prove worthy of wider publication.

OBITUARIES

Prof. Edouard Chatton

EDOUARD CHATTON, professor at the Sorbonne and director of the Marine Biological Laboratory at Banyuls-s-mer, corresponding member of the Paris Academy of Sciences, died on April 23, at the age of sixty-three, after a long illness. The French protozoological school loses one of the best—and probably the most brilliant—of its research workers.

Chatton was a pupil of Yves Delage. In 1907 he became Felix Mesnil's assistant at the Pasteur Institute in the department founded by Alphonse Laveran. Seriously wounded on the Champagne front in 1915, he went to Tunis, where he received the hospitality of Charles Nicolle at the Pasteur Institute. When Strasbourg returned to France, he was appointed as lecturer at the new University (1919), and on Bataillon's departure he became director of the Biological Institute. But his constant aim was to work in a marine laboratory. In 1932 he was elected professor at Montpellier and director of the Sète Marine Station. Finally, in 1938, he migrated to Banyuls-s-mer, one of the Sorbonne's marine stations, where he ended his life and career.

Although Chatton made fruitful incursions into the field of parasitic copepods of ascidians and sponges, and on lower parasitic Metazoa (*Orchitosoma*), almost all his activity was devoted to the study of Protozoa. His work increased to a notable extent our knowledge of numerous groups and has been the source of many general and theoretical implications.

Chatton started his scientific career in 1906 with the discovery of the parasitic dinoflagellates. A remarkably large number of new types was found, exhibiting all degrees and sorts of parasitism: external, intestinal, cœlomic, intracellular. The different types show profound changes in morphology, and in kinetics of cell cleavage; but the morphology of the spore remains that of a typical dinoflagellate. That was the origin of fruitful considerations on parasitism and its action on cellular morphology and physiology. From the study of the nucleus, he believed that *Haplozoon*, the curious parasite of annelids, was a parasitic dinoflagellate, a prediction which turned out to be true.

The careful observation of the coccidian nucleus led Chatton to conclude that Coccidia also had their origin among dinoflagellates; and after twenty-five years, shortly before the end of his career, he himself had the satisfaction of discovering the extraordinary dinoflagellates, the Coccidinides, which are parasitic in dinoflagellates. The life-cycle of these organisms is a coccidian one, but their gametes are typical dinoflagellates.

The study of nuclear fission in *Vahlkampfia* was the basis of our understanding of the type of mitosis in Protozoa and of the shattering of the "Nukleol-Centrosom" theory. When studying the life-cycle of *Entamœba dysenteriæ*, Chatton discovered the four-nucleate metacystic stage. He discovered also many new types of parasite and worked out the life-cycle of hitherto completely enigmatic organisms, such as *Pansporella*, *Siedleckia*, *Amœbidium*, *Sporomonas*, etc. He also devoted much of his time to the study of free-living and parasitic ciliates. The understanding of the affinities of the ciliates of the gills of Molluscs led to the exclusion of Hypocomidæ from the suctorians. The genesis of the sucker from a centrosome was one of the newest conclusions of this work.

The Apostomea led to much more important discoveries: the existence of two-host cycles in ciliates; the discovery and description of ciliary metamorphosis; the recognition of some of the general laws of the morphology of ciliates: the cinetosome (basal granule) is a self-reproducing body always located at the [illegible] of the ciliary 'line'; the trichocysts are formed by cinetosomes, as are the cnidocysts of the dinoflagellate *Polykrikos* (another of Chatton's discoveries). These general conceptions were verified on numerous other types of ciliates.

Chatton discovered also new Mycetes, the polysporal bacteria *Metabacterium*. He was the first to obtain the bacteriologically pure culture of an intestinal parasite—*Trichomastix* of the lizards.

Finally, to crown a fruitful career, comes the work accomplished with Madame Chatton on the determinism of sexual reproduction in some ciliates. With bacteriologically controlled cultures, the Chattons have shown that many conditions govern the determinism of copulation: a certain degree of inanition, the nature of the bacterial species present, a 'zygogenic factor' (calcium or ferric chloride, pyruvic acid, etc.) and a certain limiting *p*H value. The copulation of *Glaucoma scintillans* could even be produced at will in bacteria-free cultures.

This is only a brief summary of some of Chatton's investigations. Some three hundred papers represent the result of forty years of almost uninterrupted and concentrated work. Chatton had an extensive knowledge of zoology and parasitology, botany, cytology and microbiology. He possessed also, allied to an almost violent and exclusive love for Protozoa, a peculiar sense which enabled him to recognize every known protozoon, and to guess at first sight the life-history of so many mysterious micro-organisms. So has Chatton's work dominated protozoology. General cytology and protozoology itself have still much to gain from his theoretical conceptions.

Edouard Chatton's death deprives protozoology and biology of one of its most accomplished, brilliant and productive workers. ANDRÉ LWOFF

Mr. B. H. Barrett

BENJAMIN HILTON BARRETT, who died on June 9 after a short illness, at the age of fifty years, had for many years been a lecturer in geology at the University of Glasgow, where he graduated as a student of the late Prof. J. W. Gregory. His main interests were in stratigraphy, but he had made extensive contributions to the petrology of the red rocks of the west of Scotland, particularly of Arran and Dumfriesshire. He collaborated with Gregory in writing a book on general stratigraphy. His most important work, however, was probably that on the small coalfield of Canonbie, on the borders of Dumfriesshire and Cumberland. In collaboration with Dr. J. E. Richey he published, as a 'war-time pamphlet' of the Geological Survey, an account of this coalfield which greatly modified the interpretation of its sequence and structure, and indicated the possibilities of considerable developments in its concealed areas. For some time he was secretary of Section C of the British Association. He had also been an active supporter of the Glasgow Geological Society, of which he was president.

Barrett was a loyal colleague and a cheerful companion, a geologist of sane judgment whose early death is a loss to Scottish geology. A. E. TRUEMAN

NEWS and VIEWS

Scientific Advisory Department for Defence, Australia :

Mr. A. P. Rowe, C.B.E.

It has recently been announced that a Scientific Advisory Department for Defence is to be formed in Australia under Mr. A. P. Rowe. Mr. Rowe is probably best known as the war-time chief superintendent of the Telecommunications Research Establishment, Great Malvern, where most of the research on radar for the Royal Air Force was carried out. It was not, however, in the field of radio that his first research work was done, but in investigations into the ballistic properties of bombs. This work was carried out at the Air Ministry research station at Orford Ness, and notable contributions were made to the technique of high-level bombing. A. P. Rowe's connexion with radar began when he was appointed secretary to a committee under Sir Henry Tizard undertaking a scientific survey of the problems of air defence. He soon appreciated the importance of this new technique being developed by Sir Robert Watson-Watt and his colleagues, and it was in no small measure due to his vision and enthusiasm that research was intensified with the view of establishing quickly an early warning radar system and of investigating the application of radar technique to the problems of air warfare. In 1937 he succeeded Watson-Watt as superintendent of the Bawdsey Research Station. After the outbreak of war he gathered together many leading men of science, and the Bawdsey team grew into the large establishment known as T.R.E. (Telecommunications Research Establishment). He was quick to appreciate the extreme importance of centimetric waves for radar, and under his direction research in this field was pursued at high pressure and led to many of the outstanding radar equipments developed during the War.

Those who worked under A. P. Rowe during the War have the greatest admiration for the way in which he inspired and led so large and varied a team. Many of his methods of scientific direction were novel; for example, his well-known 'Sunday Soviets', where high-ranking officers and scientific men frankly discussed the outstanding problems of the War. On the termination of hostilities, Mr. Rowe felt that his work at the Telecommunications Research Establishment had been completed, and after a short period with the Admiralty he went to Australia to advise on the construction of the rocket-firing range for the Ministry of Supply and the Australian Government. A. P. Rowe's chief interests are in the application of scientific methods to defence; the need for the British Empire to lead in this field might almost be said to be a passion with him. Australia is indeed fortunate in having such a man to guide a department to advise on the scientific aspects of defence.

British Journal of Nutrition

The need for a journal dealing with the scientific aspects of nutrition has long been felt in Great Britain, and, but for the War, its publication would have been one of the first preoccupations of the Nutrition Society. In war-time, however, the practical application of nutrition was deemed of more immediate importance, a circumstance which led to the founding of the Society's *Proceedings*, in which reports of its conferences on practical problems of nutrition are recorded *in extenso*. The field of nutrition occupies an important part of the domain of preventive medicine, and it was fitting that in launching this publication the Nutrition Society should have had the help and support of the Royal College of Physicians in the person of Lord Moran, its president. With a return to slightly more normal times, the Society has been able to realize its original wish. Arrangements have been made with the Cambridge University Press for the production of a quarterly journal, the *British Journal of Nutrition*, which will be devoted to the publication of original work in all branches of nutrition. The fifth volume of the *Proceedings*, recording conferences held during 1946, will be the last to be published separately; in the future, they will be merged in the new journal. Abstracts of communications made at ordinary scientific meetings, a new venture of the Society, will also appear in the *British Journal of Nutrition*. The editorial board will consist of D. P. Cuthbertson, J. N. Davidson, R. C. Garry, G. Graham, J. Hammond, L. J. Harris, E. M. Hume, S. K. Kon (chairman), I. Leitch, W. C. Miller, B. S. Platt, J. A. B. Smith, and F. Yates.

The first number of the new journal will probably appear before the end of the summer. Papers for publication and letters on editorial matters should be sent to Dr. S. K. Kon (*British Journal of Nutrition*), National Institute for Research in Dairying, Shinfield, nr. Reading, Berks. Subscriptions and inquiries about the *Journal* should be addressed to the Cambridge University Press, Bentley House, 200 Euston Road, London, N.W.1. The subscription rates for non-members of the Nutrition Society are £3 per volume of four quarterly parts, and separate parts will cost 20*s*. each.

Royal Society of New Zealand

The Sixth Science Congress under the auspices of the Royal Society of New Zealand was held during the week beginning May 18. This Congress was the first held since the outbreak of war, and it was attended by more than 700 members. In addition to the General Section, there were eleven sections covering practically every department of science; in these sections 220 papers were contributed. Prof. W. N. Benson's presidential address to the Congress was entitled "Scientists Look Toward the Future".

At the annual meeting of the Council of the Royal Society of New Zealand held on May 22, the following officers were elected: *President:* Dr. E. Marsden, secretary to the N.Z. Department of Scientific and Industrial Research; *Vice-President:* Dr. R. A. Falla, director of the Dominion Museum, Wellington. The following were elected fellows of the Society: Dr. M. A. F. Barnett, Government Meteorologist, Wellington; Dr. Ernest Beaglehole, lecturer in psychology, Victoria University College, Wellington; Miss Lucy B. Moore, botanist, Plant Research Bureau, Wellington; and Prof. H. G. Forder, professor of mathematics, Auckland University College, Auckland. The T. K. Sidey Summer-time Medal and Prize were awarded to Dr. D. F. Martyn, Commonwealth Observatory, Mt. Stromlo, Canberra.

Mond Nickel Fellowships

In February 1946, Sir William Griffiths, chairman and managing director, Mond Nickel Co., Ltd., invited the Institute of Metals, the Iron and Steel Institute, the Institution of Mining and Metallurgy, the Institute of British Foundrymen and the Institution of Metallurgists to co-operate with the Mond

Nickel Co., Ltd., in awarding annually for the next fifteen years a number of fellowships, to be known as 'Mond Nickel Fellowships'. The Company offered, to make available over a number of years the sum of £50,000 to be used for awarding these fellowships. Particulars of the fellowships have now been issued. Mond Nickel Fellowships will be awarded to persons of British nationality educated to university degree or similar standard though they need not necessarily be qualified in metallurgy. There are no age limits, though awards will seldom be made to persons more than thirty-five years of age. Each fellowship will occupy one full working year; it is proposed to award up to five fellowships each year of an average value of £750. It is hoped by the aid of these fellowships to enable selected persons to pursue such training as will make them better capable of applying the results of research to the problems and processes of the British metallurgical and metal-using industries, and to increase the number of those who, if they are eventually employed in executive and administrative positions, will be competent to appreciate the technological significance of research and its results. The fellowships will be awarded to selected candidates who wish to undergo a programme of training in industrial establishments and will normally take the form of travelling fellowships; awards for training at universities may, however, be made in special circumstances. Forms of application can be obtained from the Secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1. Completed application forms must reach the Secretary of the Committee not later than September 1, 1947.

New York Academy of Medicine: Section on Microbiology

The New York Academy of Medicine has decided to form a Section on Microbiology. This new Section, which brings the number of sections of the Academy to twelve, has for its main objectives the encouragement of the exchange of information among microbiologists, and the promotion of ready contacts between clinical and laboratory investigators. The fellowship of the Section will be broad and will include not only those who have a direct interest in microbiology, but also those who deal with microbiology in their primary functions as clinicians or scientists in other branches. The officers of the newly organised Section are: *Chairman*, Dr. Gregory Shwartzman, Mount Sinai Hospital, New York; *Secretary*, Dr. Harry Most, New York University College of Medicine; *Advisory Committee*, Dr. René J. Dubos, Rockefeller Institute for Medical Research; Dr. Frank L. Horsfall, jun., Rockefeller Institute for Medical Research; Dr. Colin M. MacLeod, New York University College of Medicine; Dr. Ralph S. Muckenfuss, Research Laboratories, New York City Health Department; and Dr. John G. Kidd, Cornell Medical College.

Invention of the Telephone

In connexion with the centenary address on "Alexander Graham Bell and the Invention of the Telephone" given before the Royal Society of Edinburgh by Prof. G. W. O. Howe, an abridgment of which was published in *Nature* of April 5, Capt. G. C. Wilson, 375 McKay Street, Ottawa, has written maintaining that the telephone was invented at Brantford, Ontario, the Canadian home of the Bell family, and not at Boston. In support of this a quotation is given from a letter written by Bell in 1904, saying: "Now it so happens that the telephone was invented in Brantford during my visit to my father and mother in 1874". By 'invention' he probably meant the conception of the idea, for it was in the following February that he visited Henry in Washington and explained to him his idea of an articulate telephone. Henry encouraged him to develop the idea, which he thought might be the germ of a great invention. It was on June 2, 1875, that, while experimenting with the harmonic telegraph in Boston, the slight accident occurred which gave Bell the clue to the solution of the telephone problem, and as his assistant Watson said, "the speaking telephone was born at that moment". Where the invention was made depends on what one means by 'invention'. Bell certainly carried out experiments at his parents' home at Brantford when he was not at Boston; but it is generally agreed that it was in Boston that the experimental development occurred which can be regarded as the birth of the telephone.

Statue of Eros in Piccadilly Circus, London

Apart from its interest to Londoners and its inherent æsthetic merit, the statue of Eros, surmounting the Shaftesbury Memorial Fountain in Piccadilly Circus, London, has a scientific aspect. Originally unveiled in 1893, it is cast in aluminium alloy, the basal structure being of bronze. Its restoration, after a war-time exile, necessitated a thorough cleaning, the repair of a few defects, and the provision of a new bow and arrow. The work was entrusted by the London County Council to Mr. G. Friese Greene, of Messrs. Starkie Gardner, Ltd., of Southfields, craftsmen in metals, since the original makers are no longer in business. The cleaning was carried out with neutral soap and warm water, the surprising discovery being that there is no trace of corrosion arising from the past fifty years in the London atmosphere; with suitable care the original oxide film of the aluminium and the *patina* of the bronze have both been retained. The statue is actually cast in pieces, and the latter are threaded over a steel tree and swaged together, the joints being difficult to find. The hot forging and the cold hammering of the new bow and arrow showed that aluminium alloy can be a very useful metal for sculptors and is actually easier to work than stone. The experience with the restoration of Eros should give an impetus to designers to make more use of these 'modern metals'.

Museum of the History of Science, Oxford

The Museum of the History of Science, Oxford, whose collections, during the war period, were stored in the basement, is reopening on July 2 with an exhibition of historic scientific instruments pertaining to medicine and surgery. The exhibition will include the extremely fine collection of microscopes acquired from Dr. Reginald Clay in 1944 and now for the first time publicly exhibited. The immediate occasion of the exhibition is the meeting of the Association of Surgeons of Great Britain and Ireland and of the International Physiological Congress, both of which will be held in Oxford in July. The exhibition will be held in the School of Natural History, the ground floor room of the Old Ashmolean Building, which has not been open to the public during the past fifty years. There will be a simultaneous exhibition of books and manuscripts illustrating medicine, surgery and physiology in the New Bodleian Library.

Lady Tata Memorial Trust Awards

The Trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee in London, they have made awards as follow for research in blood diseases, with special reference to leukæmia, in the academic year beginning on October 1, 1947; the place at which the awards will be used is given in brackets: *Grants for research expenses and assistance:* Dr. Jørgen Bichel (Aarhus); Dr. Pierre Cazal (Montpellier); Dr. Pierre Dustin (Brussels); Dr. Peter A. Gorer (London); Dr. Maurice Guérin (Paris); Dr. Jozef Japa (Cracow); Dr. Edith Paterson (Manchester); Prof. Edoardo Storti (Pavia); Dr. Johannes Clemmesen (Copenhagen); and Dr. Tage Kemp (Copenhagen). *Scholarships (for whole-time or part-time research):* Dr. Simon Iversen (Copenhagen); Dr. C. F. M. Plum (Copenhagen); Dr. G. H. R. Tötterman (mainly in Helsinki).

The Night Sky in July

Full moon occurs on July 3d. 10h. 38m. U.T., and new moon on July 18d. 04h. 15m. The following conjunctions with the moon take place: July 15d. 05h., Mars 0·9° S.; July 26d. 07h., Jupiter 0·2° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Venus on July 22d. 09h., Mercury being 4·9° S. Mercury sets at 21h. at the beginning of July and is too close to the sun for favourable observation. The planet is in conjunction with the sun on July 14, and at the end of the month rises 1h. 20m. before sunrise. Venus is too close to the sun to be observed with advantage, rising about an hour before sunrise during the month. Mars, in the constellation of Taurus, rises at 1h. 30m., 1h. and 0h. 38m. at the beginning, middle and end of the month, respectively, and is a little fainter than a first magnitude star. Jupiter, in the constellation of Libra, can be seen in the earlier portion of the night, stellar magnitude about −2, setting at 1h. on July 1 and at 23h. on July 31. Saturn, in the constellation of Cancer, is too close to the sun for favourable observation, but can be seen for a short time at the beginning of July, when it sets one and a half hours after the sun. Occultations of stars brighter than magnitude 6 are as follows: July 13d. 01h. 44·9m., 31 Aries (*R*); July 27d. 22h. 12·1m., ρ Ophi. *m* (*D*). The latitude of Greenwich is assumed and *R* and *D* refer to reappearance and disappearance respectively. An occultation of Mars occurs on July 15d. 03h. 20·5m., reappearance taking place at 4h. 13·6m. The earth is in aphelion on July 5, its distance from the sun then being slightly more than 94½ million miles.

Announcements

Dr. F. H. S. Curd, Dr. D. G. Davey and Dr. F. L. Rose, of Imperial Chemical Industries, Ltd., have been awarded the Gold Medal in Therapeutics of the Society of Apothecaries in recognition of their work in the preparation of the anti-malarial drug 'Paludrine'.

Mr. D. J. B. Copp, University College, Southampton, has been appointed assistant secretary of the British Association as from July 1.

The following appointments in the University of Leeds have been announced: Mr. G. P. Meredith, lecturer in educational psychology; Mr. H. Stansfield, lecturer in mechanical engineering; Mr. S. Mackey, lecturer in civil engineering; and Dr. E. Mundel, lecturer in electrical engineering.

The following appointments have been made in the University of Sheffield: A. J. Hunt and R. A. G. Savigear, to be assistant lecturers in geography; A. E. Bender and Monica Lindsay, to be assistant lecturers in biochemistry.

The following appointments, promotions and transfers in the Colonial Services have recently been made: H. W. Dougall, agricultural chemist, Sierra Leone/Gambia; N. Lawrence, professional assistant, Royal Observatory, Hong Kong; G. H. Payne, assistant government chemist, Tanganyika; W. J. Blackie (senior chemist, Fiji), deputy director of agriculture, Fiji; H. C. Thorpe (plant breeder, Kenya), senior plant breeder, Kenya; C. E. Duff (senior assistant conservator of forests, Northern Rhodesia), conservator of forests, Northern Rhodesia; R. G. Miller (assistant conservator of forests, Northern Rhodesia), senior assistant conservator of forests, Northern Rhodesia.

Dr. L. S. B. Leakey states that a limited number of excellent casts of the mandible of the Lower Miocene ape *Proconsul* (see *Nature*, **152**, 319; 1942) are now available for distribution, as well as a good cast of the large facial fragment. Those interested should write to the Curator, Coryndon Museum, P.O. Box 658, Nairobi.

The response to the proposal to form a British Herpetological Society has been sufficient to enable further steps to be taken to inaugurate the society. An inaugural meeting will be held at the rooms of the Linnean Society, Burlington House, Piccadilly, London, W.1, on Friday, July 11, at 5 p.m. A report on the proceedings of the meeting will later be published for the benefit of members. All secretarial work in connexion with the formation of the Society is now being undertaken by Mr. Alfred Leutscher, of 5 St. Margaret's Court, London, E.12, as Capt. J. D. Romer is shortly to take up an appointment abroad.

The second annual electronics exhibition, arranged by the Institution of Electronics (North Western Branch), will be held at the Manchester College of Technology on July 22 (2.30–9·0 p.m.) and July 23 (10 a.m.–9 p.m.). Two shows of scientific films will be given each evening. Admission is by ticket obtainable from A. Coates, 16 Didsbury Park, Manchester 20.

We have received from the Murphy Chemical Co., Ltd., of Wheathampstead, Herts, a useful pamphlet of 32 pages on "Insecticides and Fungicides" supplied by them. It includes hints as to the proportions of the spray-mixtures to be used in various cases and a spraying programme for fruit and market garden crops.

Erratum. Dr. C. W. Shoppee has directed attention to the fact that Prof. T. Reichstein and Dr. L. H. Sarett have so far prepared only five of the adrenocortical hormones by partial synthesis, and not six as was stated in the article entitled "The Adrenal Cortex" (*Nature*, June 7, p. 765). The missing one is Reichstein's substance *M*, 17 (α)-hydroxycorticosterone.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Corpus Allatum and the Control of Metamorphosis in Insects

Moulting in *Rhodnius* is initiated by a hormone secreted in the dorsum of the brain, and the premature metamorphosis of the young stages is prevented by a second hormone, the juvenile hormone secreted by the corpus allatum[1-3]. This conception of growth regulation in insects has proved applicable to Orthoptera[4-7], Lepidoptera[8-10] and Coleoptera[11]. In the Diptera, on the other hand, the composite 'ring gland' appears actively to induce metamorphosis, as though it were secreting a metamorphosis-promoting hormone[12].

There is, however, some evidence that the central part of the ring gland, the part representing the corpus allatum, restrains the differentiation of the imaginal disks in the early stages in *Drosophila*[13], and recently Vogt[14] has found that the corpus allatum of the adult *Drosophila* implanted into the larva will cause a local suppression of adult characters.

This last observation implies that the corpus allatum of the adult insect is once more secreting the juvenile hormone. In the grasshopper *Melanoplus*, Pfeiffer[6] has shown that such is the case; and she has even suggested that the yolk-forming hormone of the adult insect may prove to be identical with the juvenile hormone of the young stages.

I have recently found that this is so, apparently, in *Rhodnius*. The corpus allatum of the adult *Rhodnius*, implanted into a 5th stage nymph, causes it to develop into a giant 6th stage nymph; and the secretion from the corpus allatum of the 4th stage nymph will induce egg production in the decapitated adult female.

I have found also that there is a second factor in metamorphosis. The corpus allatum of the moulting 5th stage nymph in *Rhodnius* not only ceases to secrete the juvenile hormone, but also it actively removes from the blood any traces of the juvenile hormone that remain. The decapitated 4th stage nymph exposed to the moulting hormone from the 5th stage nymph undergoes a precocious metamorphosis; but the adult characters are differentiated more completely if the 5th stage nymph retains its corpus allatum. The corpus allatum of the 5th stage nymph in the late stages of moulting or of the newly moulted adult, implanted into intact 3rd or 4th stage nymphs, reduces the activity of the juvenile hormone so that when they reach the 5th stage some of them show a partial metamorphosis (Figs. 1 and 2).

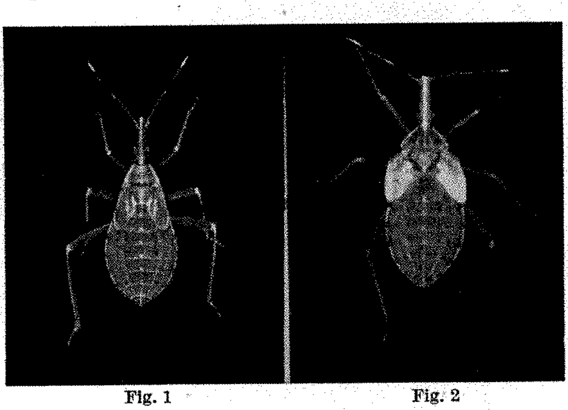
Fig. 1 Fig. 2

Fig. 1. Normal 5th stage nymph

Fig. 2. 5th stage nymph following implantation of corpus allatum of young adult into the 3rd stage, showing partial metamorphosis

This effect is always diffused throughout the body; it is never localized in the region of the implant, as the effect of the juvenile hormone often is. It is unlikely, therefore, that it is due to the secretion of an imaginal or metamorphosis hormone.

I suggest that it may be the active elimination of juvenile hormone in the Diptera which creates the impression of a 'metamorphosis-promoting hormone'. If it be supposed that these two factors, the cessation of secretion of the juvenile hormone and the active elimination of this hormone, differ in their relative importance in different insects, we may perhaps have the basis for a theory of metamorphosis which will be applicable to all groups of insects.

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Evolutionary Significance of Periodicity of Variation-Intensity and Population-Flux in the Desert Locust

The periodic mass-increase in the population of the desert locust, *Schistocerca gregaria* (Forskål), which ranges from Africa to India, is a phenomenon known since Biblical times. The compilation of historical records of the last century and a half has established an *average* 11-year cycle of mass-increase, although the individual periods are far less regular. Following Uvarov's work[1,2], the existence of two phases, namely, the swarming or *gregaria* phase and the non-swarming or *solitaria* phase, has also been established. These phases differ morphologically and in other ways, are connected by a graded series of intermediates, and are evidently of no genetical significance; they can be produced at will by the simple process of crowding and thinning.

The last cycle of increase lasted from about 1926 until 1931, followed by a *solitaria* period of several years. We are now in the middle of another cycle which started in 1940. As a result of considerable work in various countries during the last fifteen years, we now possess a fairly comprehensive knowledge of the migrations and population-flux of this species. Briefly, the species in *solitaria*-years is confined to certain desert tracts extending from West Africa via the Red Sea coast to the Persian coast and Western India, including Rajputana; the population is low, usually not exceeding about 1,000 per sq. mile, and often much less. In *gregaria*-years the population increases enormously (considerably more than 10,000 per sq. mile) and the range also increases, the species spreading to Southern Europe (extending even to

Great Britain in some years), Transcaucasia, Central Asia, Peninsular India and Eastern India (Assam).

I have already shown that during the *solitaria* phase the species is polymorphic in regard to the number of eye-stripes, the wild populations consisting of two main types (6- and 7-eye-striped), with 8-striped forms turning up occasionally in extreme *solitaria*-years (1936–38). During the *gregaria* period, that is, in swarms, *only* 6-striped individuals occur, and the eyes are more heavily pigmented. Occasionally, 5-striped individuals occur in laboratory rearings, evidently as mutants, but such individuals have not yet been found wild. I have elucidated[3,4] the pigmentary basis of stripe formation and their development. The eye-stripe polymorphism is partially correlated with the number of moults[4] and also with the number of antennal segments[5]. In addition to and superimposed upon these variations, two types of colour variations occur in the *solitaria* phase: the majority of wild individuals (91 per cent) are blue-grey as adults and green as hoppers, while the remainder are fawn as adults and buff as hoppers[6,7].

The eye-stripe polymorphism was noted in India and North Africa during the *solitaria* period of 1932–39. It was absent during the past swarming periods, as judged from the examination of museum specimens. During the present swarming cycle (1940–) the polymorphism has again practically disappeared, only a few 7-striped forms being found in North-West India during 1940–46 *after* the main swarms had left; no 8-striped forms have yet been found (Y. R. Rao, *in litteris*).

From the foregoing account, the following important conclusions emerge: (i) The population fluctuates periodically, the 'plague period' of high numbers corresponding with a considerable increase of range of the species. (ii) As regards variation intensity, the species is comparatively stable during the plague or *gregaria* period but highly polymorphic during the *solitaria* period when the population is low. (iii) The phenomenon is periodic and evidently occurs over a wide range (India to Africa) more or less simultaneously. (iv) It would appear that the 7- and 8-striped individuals, which make their appearance during *solitaria* periods when selection-pressure is low probably owing to reduced numbers, are eliminated, presumably by selection, during the *gregaria* periods of high population and increased selection-pressure.

Crossing results show that 6-striped individuals produce both 6- and 7-striped forms in F_1 and F_2 generations. Other results need not be discussed here for the present.

The evolutionary consequences of these phenomena lie in the fact that we have here probably the first clear case of the Wright – Dubinin effect (of random or automatic increase of variation intensity in small, partially isolated populations; random 'drift' of Wright[8]; genetico-automatic processes of Dubinin[9]) in natural populations showing periodic fluctuations. As, fortunately, the periods are small (average eleven years), it is possible to test the results repeatedly and even calculate the rate of flow of a particular variation in Nature[10].

It is interesting that the opposite effect, namely, an increase of variation intensity with increased abundance, is also known to occur[11-13], and Fisher has even provided the mathematical basis of it. The question whether these two opposite effects are due either to totally different mechanisms, or are merely the different expressions of fundamentally the same mechanism, cannot be discussed here, but must be borne in mind. The Hagedoorn effect[14] of steady random (automatic) decay of variation intensity in the total absence of selection has not been demonstrated in Nature; it has been criticized on mathematical grounds by Fisher as being too slow to be ever of any significance in evolution.

A fuller account will be published elsewhere.

M. L. ROONWAL

Zoological Survey of India,
Benares Cantt.
Feb. 28.

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A Tubal Factor Concerned in the Denudation of Rabbit Ova

McClean and Rowlands[1] found that hyaluronidases from several sources were able to liquefy the viscous gel cementing the follicle cells around freshly ovulated rat ova, thereby denuding the latter. This was confirmed by Fekete and Duran-Reynals[2] for the mouse and by Leonard and Kurzrok[3] for the rat. On the basis of their observations, McClean and Rowlands suggested that the gel consisted of hyaluronic acid, and that the function of seminal hyaluronidase was to bring about denudation of the egg prior to fertilization. Pincus[4] had noticed that although rabbit cumuli placed in rabbit sperm suspensions underwent rapid disintegration, quite frequently a layer of more densely packed follicle cells (corona radiata) remained surrounding the egg. On the other hand, when this action took place inside the Fallopian tube, the ova became completely denuded within 1½–3 hours of ovulation if insemination had previously occurred, or within 6–8 hours if the mating had been with a vasectomized buck.

Since, in an investigation of the action of hyaluronidase on rabbit cumuli *in vitro*, it had been observed that the corona radiata appeared invariably to remain intact, it was decided to study more closely what part was played by the Fallopian tube in bringing about complete denudation of rabbits' ova.

Female Dutch rabbits were injected intravenously each with 50 I.U. of chorionic gonadotrophin to induce ovulation. Twelve hours later they were killed by air embolism and the Fallopian tubes were removed and washed through with physiological saline to recover the ova, which, in these circumstances, were always embedded within cumuli. The cumuli were placed in fresh saline to remove any material that might have been washed from the tubes, and divided so as to contain two ova each. The portions of cumulus were then placed in separate cells in the minimum amount of fluid. Two ejaculates of rabbit semen were suspended in 20 ml. of Baker's solution[5],

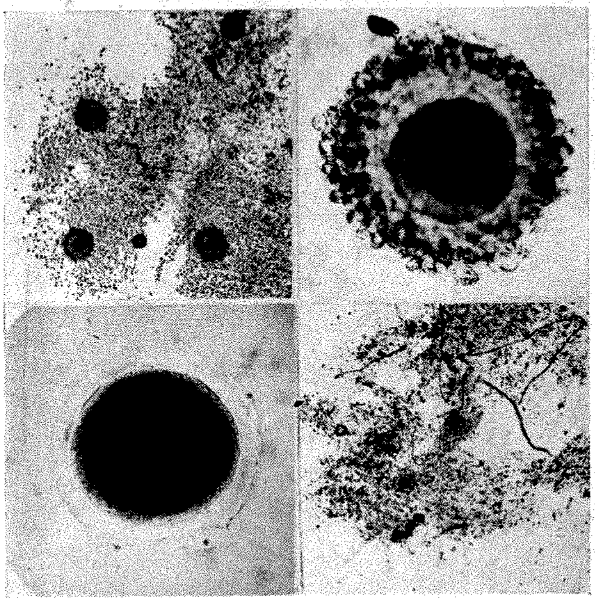

Fig. 1. UNTREATED CUMULUS CONTAINING THREE OVA. (× 15)

Fig. 2. OVUM SURROUNDED BY CORONA RADIATA, AFTER ACTION OF HYALURONIDASE ON CUMULUS. (× 145)

Fig. 3. COMPLETELY DENUDED OVUM, RECOVERED FROM FALLOPIAN TUBE INTO WHICH IT HAD BEEN INSERTED WHILE IN THE CONDITION SHOWN IN FIG. 2. (× 145)

Fig. 4. CUMULUS CONTAINING TWO OVA, RECOVERED FROM FALLOPIAN TUBE INTO WHICH IT HAD BEEN INSERTED WHILE IN THE CONDITION SHOWN IN FIG. 1. (× 15)

the suspension then being divided into two portions both of which were centrifuged for 10 min. The supernatant from one portion (*A*) was removed and fresh Baker's solution added to the original level, the sperms being stirred up. The sperms in the second portion (*B*) were stirred up in their original supernatant. 0·2 ml. aliquots of the three fluids (*A*, *A* supernatant, and *B*), the sperms being fully active in *A* and *B*, were then added to the cumuli in their cells, each fluid being added to two cumuli. The times required to free the eggs from their cumuli are shown in the table.

Fluid	Time required to free ova (min.)	Average time (min.)
A	21	26
A	31	
A supernatant	20	
A supernatant	26	23
B	20	20
B	20	

In all the above the coronæ remained intact, and it is clear that the presence of spermatozoa is unnecessary for disintegrating the cumulus, hyaluronidase in solution being adequate for the purpose. Thirty hours later the coronæ were still intact. The addition of a tubal extract, made by grinding two Fallopian tubes with sand, extracting with saline and filtering, was also without effect on the corona, neither did the addition of 10 units of standard freeze-dried bull semen filtrate (Swyer and Emmens[6]) produce any effect within 1½ hours.

In the next series of experiments, cumuli were obtained as before from three rabbits, some being placed in a solution consisting of 10 units of hyaluronidase (bull) in 2 ml. saline which freed the eggs within 10 min., leaving the coronæ intact. Under ether anæsthesia the abdomen was opened in three other rabbits, and three or four eggs treated as above were inserted into the fimbriated end of one tube while an untreated cumulus was inserted into the other in each rabbit. The wounds were closed in the usual way. Three hours later the rabbits were killed, the tubes washed out and the eggs recovered. The cumuli which had been inserted intact were recovered intact, while the treated eggs were recovered either completely denuded or with only a few adherent follicle cells (Figs. 1–4).

It is clear, therefore, from these results that disintegration of the corona radiata of the rabbit's ovum is effected, not by the action of hyaluronidase, but by some influence exerted by the Fallopian tube. This influence comes into play after the cumulus has been removed, ordinarily by the action of hyaluronidase, but in the absence of insemination, by the much slower action of the tube itself, as shown by the time relations established by Pincus. The nature of the tubal factor is not clear at present; the fact that tubal extracts are without action on the corona or cumulus would seem to rule out a purely chemical effect, and perhaps suggest a mainly mechanical one dependent, for example, on ciliary action and muscular contraction. Attempts at demonstrating such an action have been made by inserting hyaluronidase-treated ova into the tubes of pseudo-pregnant rabbits (in which tubal activity, as a result of the influence of progesterone, might be considered as diminished) and also by instilling 0·2 per cent procaine along with the treated ova into the tubes of normal rabbits. In all these experiments the recovered ova were denuded of their coronæ, so that no conclusions could be drawn from them.

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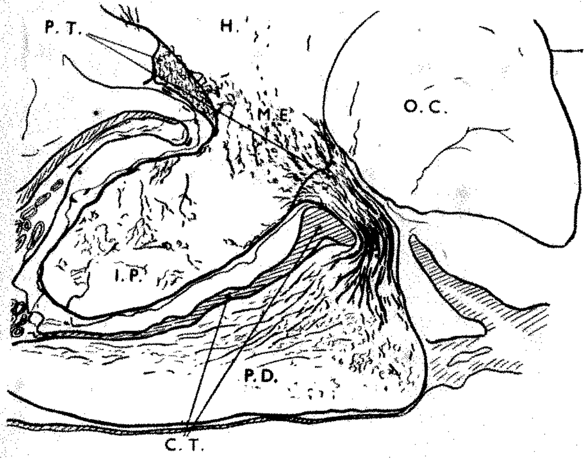
The Hypophysial Portal Vessels of the Porpoise (*Phocæna phocæna*)

IF the nervous system influences the activity of the anterior lobe of the pituitary gland by liberating some humoral excitant into the hypophysial portal vessels, which in turn transmit the substance to the gland[1,2], then it would seem likely that these portal vessels would be widely distributed among the vertebrates. It is well known that in birds and some mammals (whale, sea-cow, Indian elephant, armadillo and porpoise) the neural lobe of the pituitary is separated from the pars distalis of the anterior lobe by a connective tissue septum, and it seemed possible that this septum might interrupt the path of the portal vessels in these animals.

To investigate this possibility a male porpoise (*Phocæna phocæna*) weighing 136 lb., and 5 ft. in length, was injected in a cranial direction through the vertebral arteries with India ink. After completing fixation, the hypothalamus, pituitary and surrounding structures were taken *en bloc*, serially sectioned in a sagittal plane at 150 μ, and the sections stained with Biebrich scarlet. The sections show clearly that the porpoise possesses a hypophysial portal system of blood vessels similar to that of other mammals. The pars tuberalis extends upwards to embrace the tuber cinereum as a ring-like collar. The portal vessels start as the characteristic sinusoidal



MID-LINE SAGITTAL SECTION THROUGH THE HYPOTHALAMUS AND PITUITARY GLAND OF A PORPOISE. VESSELS INJECTED WITH INDIA INK. CAMERA LUCIDA DRAWING. × 9·3

C.T., connective tissue septum, derived from the dural capsule of the gland, intervening between the infundibular process and the pars distalis; *H.*, hypothalamus; *I.P.*, infundibular process; *M.E.*, median eminence containing the characteristic vascular loops and tufts; *O.C.*, optic chiasma; *P.D.*, pars distalis; *P.T.*, pars tuberalis

loops in the median eminence, drain into the vascular plexus of the pars tuberalis, where they unite to form the widely dilated trunks which pass ventrally into the sinusoids of the pars distalis. The detailed arrangement is very similar to that of the rabbit, in that the trunks of the vessels are contained in a thick pillar of cells (termed the zona tuberalis in the rabbit[3]), which passes through the diaphragma sellæ by a foramen separate from that transmitting the infundibular stem.

Thus the pituitary gland of the porpoise, in spite of the septum intervening between the two lobes, conforms with that of other mammals in possessing the typical vascular connexions between the median eminence and pars distalis. It is of interest that Drager[4,5] finds the pars distalis of the bird and porpoise to be free of nerve fibres.

I wish to thank Mr. D. A. Parry, Department of Zoology, Cambridge, for the porpoise.

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Cytosiderosis and the Genesis of Arteriosclerosis and other Fibrous-Tissue Reactions

CYTOSIDEROSIS is a diffuse metabolic disorder characterized by the deposition of large quantities of iron pigment, at first mainly in the liver and later in other organs and tissues of the body[1,2]. It occurs consistently in adult pellagrins, although it is commonly seen also in other members of the African population not suffering overtly from acute episodes of malnutrition[3].

Serial liver biopsies of the same pellagrin have revealed that the iron pigment is lodged first in the hepatic parenchyma and then later in the reticulo-endothelial system in the liver. By piecing together the evidence derived from our biochemical and pathological studies, we were able to show that the second stage of the disease is characterized by a true siderosis whereby the iron pigment is steadily disseminated via the gut mesenteric glands into the thoracic duct and eventually by the blood circulation[4]. The absorption of such large molecules presupposes a disturbance in digestion and in the absorptive capacity of the gut epithelium.

Obstruction to the pancreatic duct of cats fed a particular diet containing large quantities of iron over a period of time results in the appearance of excessive amounts of iron in the liver[5,6]. This was attributed to a vitamin A deficiency which impaired the absorptive efficiency of the gut epithelium[6]. Our own investigations in cats have shown that when the pancreatic ducts are tied, iron can still appear in the liver when vitamin A is being actively absorbed. Severance of the pancreatic duct and a high iron-containing diet greatly expedite this extraordinary disturbance in iron metabolism in cats. Normal cats fed the same diet only develop an iron flush in the Kupffer cells, whereas, over the same period of time, cats with obstructed pancreatic ducts accumulate massive quantities of iron pigment in the liver. From these experiments in cats, it is evident that a badly balanced diet can lead to the accumulation of iron-containing molecules in the reticulo-endothelial system.

It has been shown in our laboratory that the pigment in human cytosiderosis is a relatively inert molecule. The intravenous injection of this pigment into normal cats results in the accumulation of large masses of pigment, at first in the reticulo-endothelial system in the form of coarse clumps, and later in the liver cells situated near the medium-sized portal tracts, such as we have described in the second stage of cytosiderosis in African pellagrins. Injection of colloidal iron in amounts equivalent to the iron present in the pigment over the same period leads only to a slight flushing of the Kupffer cells similar to that noted in intact cats fed the equivalent of approximately 40 mgm. of iron per diem.

Whether or not the second stage of cytosiderosis in the African is associated in particular with a disorder of the pancreas is not of immediate consequence, although we have shown that in malnourished infants the early stages in the genesis of cystic fibrosis can be detected. The important issue, so far as this communication is concerned, resides in the observation that sooner or later in cytosiderosis an inert molecule first found intracellularly in the liver is excreted via the bile, then absorbed by the gut and disseminated by the systemic circulation. The flooding of the circulation with macromolecules can result in a number of extraordinary reactions constituting the macromolecular syndrome[7]. The noteworthy features of this syndrome are the production of arteriosclerosis, fibrosis of the spleen and curious hæmatological reactions. While the experiments conducted on the macromolecular syndrome by Hueper and others were mainly of an acute character, nevertheless the conclusions are unequivocal.

If now it is remembered that cytosiderosis in the African occurs very frequently in the third, and can be very extensive in the fourth decade, it is evident that a large, inert, iron-containing molecule is steadily flooding the circulation in minute amounts for ten to fifteen years. Such a state of affairs could quite easily lead to those conditions optimum for the development of premature arteriosclerosis and other instabilities of the cardiovascular system known to occur in young Africans[8,9], in addition to cirrhosis of the liver, the tendency to keloids[10], reticulosis, etc. For such reactions to occur, it would appear that chronic malnutrition associated with disease of the liver and the pancreas might also be essential attributes of the background of the African.

While in African pellagrins we were able to track the movements of the macromolecule by virtue of its iron-containing fraction, it is also very likely that other types of macromolecules—protein, polysaccharides, lipoproteins and the like—may enter the circulation in conditions similar to those described for cytosiderosis. A new approach is now available for attacking the several problems connected with the tendency to fibrous tissue reactions noted in many metabolic disorders, and expressed as arteriosclerosis, hypertension, reticulosis and cirrhosis. Investigations are proceeding actively in this laboratory to elucidate this and other aspects of the problem.

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Hydrochloric Acid Formation in the Gastric Mucosa

IN a recent article[1] concerning the mechanism of high acid production by bakers' yeast and its bearing on hydrochloric acid formation in the stomach, reference was made by us to the work of Davies *et al.*[2,3] on the respiratory exchange and hydrochloric acid production by the gastric mucosa of the frog. It was pointed out that though such results appear of value for the theory of formation of hydrochloric acid, they in no way disprove the *essentials* of the theory proposed from our Department as to the manner of formation of the acid[4]. After reading the recent communication of Davies *et al.*[5], we can only reaffirm our conclusions in this respect concerning their data.

In their communication, and referring presumably to their findings that the maximum Q_{HCl} is twice the maximum Q_{O_2} for the isolated gastric mucosæ, they say that these "facts rule out theories dependent on the production of hydrogen ions by the fermentation or oxidative degradation of any carbon compound". Also, they write that a statement of ours to the effect that a cyclical process (with H ions deriving from an organic acid) could give a Q_{HCl} far higher than Q_{O_2} "is not justified".

Both these statements of Davies *et al.*[5] may be shown to be incorrect, as indicated in the accompanying cyclical scheme. In this the hydrogen ions are assumed to come from phosphoglyceric acid, produced by the dehydrogenation of triosephosphate; but, *it is to be understood that this reaction is chosen only for illustration*, and that some other reaction, or indeed several reactions, involving acidic production may be operative. The scheme is presented in stages which are numbered for convenience of reference. Some obvious connecting links have been omitted. For ease of presentation, single molecules or ions appearing in the reactions or exchanges have been given.

In the scheme, fluid containing potassium chloride in strength approximately isotonic with blood is excreted in a special region and flows past the acid region, potassium ions being exchanged for hydrogen ions. The hydrogen atoms which wander from the triosephosphate are received by an acceptor, but are not further transferred in this region of the cell to molecular oxygen.

In the fifth stage, the reversal of the dehydrogenation occurs—in another part of the cell—hydrogen ions now disappearing from solution and an alkalinity corresponding to the acid secreted being produced. In stage 6, the view of Davies *et al.*[5] that carbon dioxide *from the blood* neutralizes the hydroxyl ions and forms HCO_3 ions (passing via H_2CO_3, the formation of the carbonic acid being catalysed by carbonic anhydrase), is included, as this appears now to interpret well the final exchanges; but, as stated in our article[1], any view assuming carbonic anhydrase to act at the immediate site of the acidic formation would appear improbable. In stage 7, HCO_3 ions exchange for chlorine ions across the membrane.

A cyclical scheme of the above type could also be developed for other views such as those of Bull and Gray[6], which turn on the formation of an organic acid; and it would appear, too, that carbonic acid as a source of hydrogen ions could be similarly developed. The scheme presented is perhaps best described as a working hypothesis (and present views of hydrochloric acid formation in the stomach can be regarded as little more), but its most essential feature can be illustrated by the biological model of bakers' yeast working under certain conditions and producing a high degree of acidity.

Considering now the quotient $Q_{\text{HCl}}/Q_{\text{O}_2}$ which could result from such a scheme, it will be assumed for illustration that the phosphoglyceraldehyde and phosphoglycerate are shifted from a 9 : 1 to a 1 : 9 ratio (and then restored to the former ratio), and that for both conditions the equation :

CYCLICAL SCHEME FOR THE PRODUCTION OF HYDROCHLORIC ACID

	Lumen	Intracellular substance		Blood or inter-cellular spaces
1.		$R.\text{CHO} + \overset{+}{\text{K}} + \overset{-}{\text{Cl}} + \text{Ac}$		$\overset{-}{\text{Cl}} + \text{CO}_2 + \text{H}_2\text{O}$
2.	$\overset{+}{\text{K}} + \overset{-}{\text{Cl}}$	$R.\text{CHO} + \text{Ac}$		$\overset{-}{\text{Cl}} + \text{CO}_2 + \text{H}_2\text{O}$
3.	$\overset{+}{\text{K}} + \overset{-}{\text{Cl}}$	$\overset{+}{\text{H}} + R.\overset{-}{\text{COO}} + \text{AcH}_2$		$\overset{-}{\text{Cl}} + \text{CO}_2 + \text{H}_2\text{O}$
4.	$\overset{+}{\text{H}} + \overset{-}{\text{Cl}}$	$\overset{+}{\text{K}} + R.\overset{-}{\text{COO}} + \text{AcH}_2$		$\overset{-}{\text{Cl}} + \text{CO}_2 + \text{H}_2\text{O}$
5.	$\overset{+}{\text{H}} + \overset{-}{\text{Cl}}$		$R.\text{CHO} + \overset{+}{\text{K}} + \overset{-}{\text{OH}} + \text{Ac}$	$\overset{-}{\text{Cl}} + \text{CO}_2 + \text{H}_2\text{O}$
6.	$\overset{+}{\text{H}} + \overset{-}{\text{Cl}}$		$R.\text{CHO} + \overset{+}{\text{K}} + \overset{-}{\text{HCO}_3} + \text{Ac}$	$\overset{-}{\text{Cl}}$
7.	$\overset{+}{\text{H}} + \overset{-}{\text{Cl}}$		$R.\text{CHO} + \overset{+}{\text{K}} + \overset{-}{\text{Cl}} + \text{Ac}$	$\overset{-}{\text{HCO}_3}$

$$E_h = E'_0 - \frac{RT}{nF} \ln (\text{Red.})/(\text{Ox.})$$

applies with the same E'_0 value; then the free energy requirement per equivalent of hydrogen ions produced, to restore the condition as in the scheme, is approximately 1,700 cal., the free energy change per mol. oxygen used in oxidizing carbohydrate being about seventy times this value[7]. For the interpretation of the Q_{HCl}/Q_{O_2} values found by Davies *et al.*[5], this allows a very wide latitude for efficiency considerations, etc.

The views of Davies *et al.*[8,5] with respect to electric force playing an important part in the elaboration of hydrochloric acid, by way of splitting water molecules, we find unsatisfactory chiefly for the following reasons: (1) Their hypothesis appears to arise mainly from the mistaken view that the facts of the respiratory exchange preclude an explanation from the formation of hydrogen ions by organic acid. (2) No indication is given as to the manner in which such electric power operates. Other objections could be also advanced.

We regret having misinterpreted a statement in one of the summaries of Davies[3]. From evidence at our disposal, we concluded that Q_{HCl}/Q_{O_2} figures greater than 2·0 had been obtained, so that the sentence "In bicarbonate saline the Q_{HCl} sometimes rose to twice the Q_{O_2} without causing visible damage to the tissue" seemed to imply that beyond a Q_{HCl}/Q_{O_2} of twice, the tissue was damaged. We are glad that this point has been cleared up (but for the general theoretical interpretation it is of minor significance); and also that a printer's error in our article has now been corrected by Davies *et al.*[5].

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Volume Change Accompanying the Splitting of Ribonucleic Acid by Ribonuclease

A PREVIOUS investigation by Linderstrøm-Lang and Jacobsen[1] has shown that dilatometric measurements can be useful in the study of the enzymatic breakdown of macro-molecules. Thus it was found that the contraction accompanying the tryptic and chymotryptic splitting of lactoglobulin was too great to be compatible with the assumption that the degradation of this protein is exclusively caused by an opening of peptide bonds in a rolled-up peptide chain. A recent extension of these experiments to include other proteins has made it likely that this phenomenon is common to the molecules of globular proteins, and that it is the breakdown of the superstructure of these molecules that causes the abnormal contraction.

We have thought it of interest, in analogy with these investigations, to study the breakdown of another type of macro-molecule, the nucleic acids. We have chosen ribonucleic acid because one of the authors (Chantrenne) was familiar with this substance from previous work. The particular ribonucleic acid preparation used was made according to Chantrenne (ref. 2, fraction A), but from Danish bakers' yeast. The product obtained was somewhat different from that previously described[2], and we therefore give the titration curves (Fig. 1) for the Danish nucleic acid before and after degradation with ribonuclease (prepared according to Kunitz[3]).

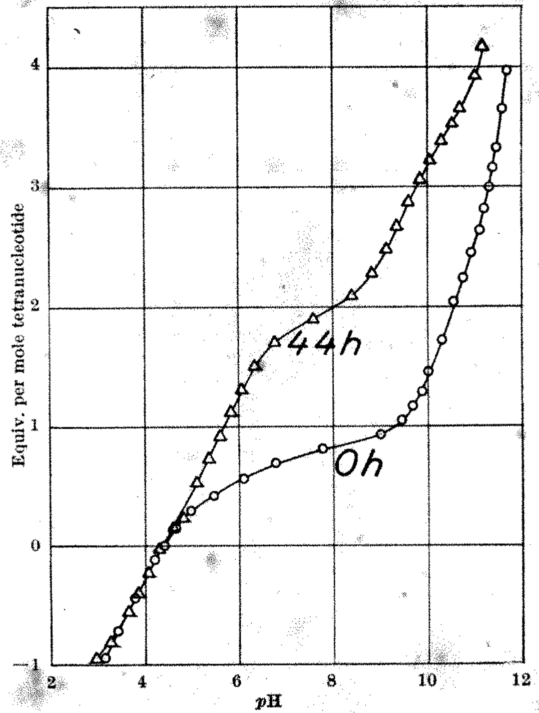

Fig. 1

It will be observed that the change in pH caused by the action of ribonuclease is negligible around pH 4·6 and below, and we can, therefore, feel confident that the volume change observed during an enzymatic process at this pH does not originate in an interchange of protons between the nucleic acid and the medium.

The following experiments may serve as an example of our results. *Enzymatic system.* Sodium salt of ribonucleic acid 1 per cent, pH 4·6, sodium chloride 0·1 N, ribonuclease 0·0125 and 0·005 per cent (curves I and II respectively), $T = 30°$. Dilatometric technique as described in ref. 1, but reduced to micro scale. *Determination of the opening of phosphate bonds:* microtitration with sodium hydroxide, end-point pH 8, indicator cresol red. Due to the continued action of ribonuclease at the end-point, extrapolation to zero titration time was made by means of titration-time curves.

The results are seen in Figs. 2 and 3. ΔP denotes the number of phosphate bonds opened, ΔV the volume change. The data are calculated as ml. and equivalents per mole tetranucleotide.

It will appear from the graphs that our results are compatible with earlier work on the action of ribonuclease[4-7], namely, that this enzyme has two functions, one as a 'depolymerase' or 'denaturase' and the other as a 'phosphatase'. In its first capacity it acts very rapidly, presumably preparing the nucleic acid molecule for the slower attack by the phos-

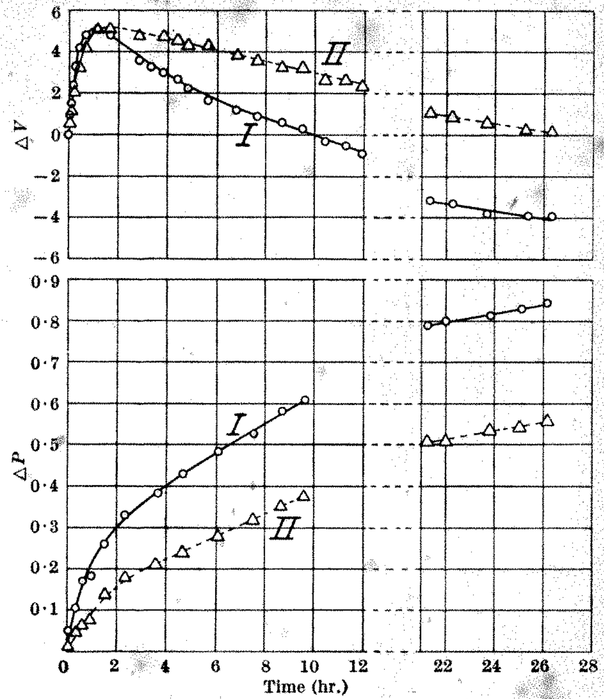

Fig. 2

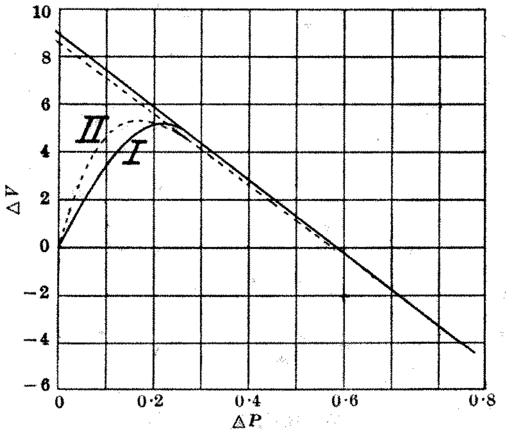

Fig. 3

phatase which breaks the molecule down to tetranucleotides. The 'depolymerization' is accompanied by an increase, the splitting of the phosphate linkages by a decrease, in volume. If we consider the right-hand part of the curves in Fig. 3, where the cleavage of the phosphate linkages is predominant, we observe that they are straight lines with a slope $\Delta V/\Delta P$ of about − 13 ml./equiv. Assuming now that this relation holds true for the phosphate-bond cleavage during the entire enzymatic process, we obtain the total volume increase due to 'depolymerization' by extending the lines until they intersect the axis of ordinates. In this way we find a value of 8–9 ml. per mole tetranucleotide, or about one per cent of the nucleic acid molecule. We shall not discuss the significance of this rather hypothetical value here, but we would like to point out the similarity of the problem to that met with in the case of proteins. In both cases an initial process involving a breakdown of some superstructure seems to be required before the 'true' chemical degradation can set in. We cannot offer any satisfactory explanation why this process is accompanied by a contraction of the protein and a dilatation of the nucleic acid, but we are willing to follow Gulland and his collaborators in assuming that some kind of 'physical' bond between the purines and pyrimidines is present and put out of action in the latter case. The possibility of resonance is considerable in these substances. But it must be borne in mind that the opening of bonds involving ionogen groups (see ref. 8) is unlikely, due to the constancy of pH.

Finally, we would point out that the value $\Delta V/\Delta P = -13$ is surprisingly high for the splitting of an ester bond when, as in the present case, the hydroxyl group belonging to the phosphoric acid remains uncharged. In the splitting of glycerophosphate by acid phosphatase at pH 4·6, the corresponding value is about − 3 ml./equiv. This question requires further investigation.

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Effect of Ultra-Filtration and Carbon Dioxide on the Prothrombin Activity of Plasma

It is well known that the prothrombin in plasma is easily susceptible to inactivation, but the nature of the factors responsible for this inactivation has not been clearly understood. M. Gerendas[1] has stated that the inactivation of thrombin is due to two parallel and separate causes, namely, adsorption, and a fermentative inactivating process.

Investigations carried out in this laboratory on the nature of the factors responsible for the inactivation of plasma prothrombin have shown that the prothrombin activity of plasma which has been inactivated on keeping can be regained either by ultra-filtration or by passing carbon dioxide through the plasma; hence it is reversible. However, if the plasma is stored for a longer period (more than a week), the prothrombin undergoes irreversible inactivation, and in such cases neither ultra-filtration nor carbon dioxide has any effect. It should be noted, however, that neither carbon dioxide nor ultra-filtration has any effect on the prothrombin activity of fresh plasma. We have also observed that in the case of inactivated plasma, on adding the ultra-filtrate to the ultra-filtered plasma, the prothrombin is inactivated. These experiments clearly show that the inactivation of prothrombin is due to the presence or formation of substances which can be removed by ultra-filtration.

While studying the prothrombin activity in pathological conditions, such as tuberculosis and jaundice, we found that the low prothrombin activity in such cases can invariably be increased by ultra-filtration or by passing carbon dioxide through the plasma.

In the following table are given some of the typical results of our experiments.

Coagulation time (in sec.)

Plasma	Original plasma	After ultra-filtration	After passing CO_2 for 30 sec.	Prothrombin activity of 0·2 c.c. ultra-filtered plasma + 0·2 c.c. thrombo-plastin	
				+0·2 c.c. water	+0·2 c.c. ultra-filtrate
Bovine plasma					
Fresh	14	—	14	—	—
	19	—	19	—	—
After 24 hr.	30	22	20	—	—
After 48 hr.	28	20	—	21	51
After 72 hr.	42	24	—	27	64
Human plasma (normal)					
Fresh	12	—	13	—	—
After 5 hr.	44	17	—	20	28
Human plasma (pathological)					
Jaundice					
Fresh	15	—	10	—	—
Tuberculosis					
(*a*) Pulmonary					
Fresh	21	—	—	—	—
After 8 hr.	35	20	14	25	32
Fresh	No clotting until 420 sec.	—	46	—	—
After 4 hr.	,,	17	47	—	—
Fresh	17	—	13	—	—
After 3 hr.	25	—	13	—	—
(*b*) Miliary	No clotting until 600 sec.	—	105	—	—

These results show an interesting parallelism between the effect of ultra-filtration and carbon dioxide on the prothrombin activity of plasma.

The mechanism of the effect of carbon dioxide on prothrombin activity of plasma is under investigation.

Our thanks are due to Prof. V. Subrahmanyan for his interest in these investigations.

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March 30.

[1] Gerendas, M., *Nature*, **157**, 837 (1946).

Influence of Cations in the Production of Citric Acid by Yeast

Succinic and citric acids were found by Wieland and Sonderhoff[1] to be products of the dissimilation of acetic acid by yeast under aerobic conditions. But whereas succinic acid was always obtained in a yield of 5 per cent, the yield of citric acid varied; it amounted to 10 per cent only when they used barium acetate.

Sonderhoff and Deffner[2] re-investigated the production of citric acid in a more systematic manner. They found a yield of 25 per cent under certain conditions by using barium acetate. They suggested, therefore, that this yield of citric acid could be explained by the insolubility of barium citrate. The insoluble barium citrate remains unaffected while sodium citrate, which is very soluble in water, can be easily oxidized further; and it is then easy to understand why traces only of citric acid are found by oxidizing sodium acetate.

Virtanen and Sundman[3] indicated that production of citric acid takes place by oxidizing magnesium acetate, although magnesium citrate is soluble in water. They did not give a complete explanation, but they assumed that magnesium and barium probably have an influence at some stage in the formation of citric acid.

In a series of experiments, we were able to demonstrate that by using cations forming easily soluble citric salts (sodium, potassium and lithium), almost no citric acid was found. We think that the citric salts of these cations can pass easily through the cell wall, and they are dissimilated in the interior. In presence of cations forming insoluble salts (lanthanum, barium and strontium) we obtained a yield of roughly 15 per cent citric acid, because the insoluble citric salts cannot penetrate to the interior of the cell.

In the case of magnesium we found that complex salts are formed. The complex anions have a big volume and they cannot pass through the cell wall. In the case of barium citrate, difficulty in penetrating the cell wall is due to the insolubility of the salt; in the case of magnesium citrate to formation of a complex.

By using ordinary yeast, we found that the citric salts of sodium and potassium are easily dissimilated; those of magnesium and barium scarcely at all. By treating yeast with liquid air[4] and thus destroying the cell wall, we found equal dissimilation of sodium, magnesium, calcium and barium citrates. However, by this method of using yeast with destroyed cell wall, we were not able to oxidize acetic salts.

A detailed account of the experiments will be published elsewhere as soon as the investigation is completed.

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[1] Wieland, H., and Sonderhoff, R., *Ann.*, **499**, 213 (1932).

[2] Sonderhoff, R., and Deffner, M., *Ann.*, **536**, 41 (1938).

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Slow Cosmic Ray Mesons at Sea-Level

During the latter part of 1938, a high-pressure cloud chamber designed by the late Prof. E. J. Williams was constructed to investigate certain phenomena concerned with cosmic ray mesons. It was hoped that by using high pressures, giving a long sensitive-time, that mesons would be observed coming to the end of their range in the cloud chamber. Four such examples have been obtained[1]. A similar example was also found by E. J. Williams and G. E. Roberts using a large cloud chamber working at atmospheric pressure[2]. In each case, the meson is observed to come to rest and then to decay with the emission of a β-particle. From these results, it is estimated that the proportion of slow mesons ($\beta < 0{\cdot}25$) in cosmic radiation at sea-level is about 0·05 per cent. In these experiments, no evidence has been found of the disintegration of nuclei by mesons as reported recently by D. H. Perkins[3], and by C. F. Powell and G. P. S. Occhialini[4]. Little information concerning the frequency of such events at sea-level is available, and it was thought that it would be worth while to expose some photographic emulsions in the same room as the cloud chamber.

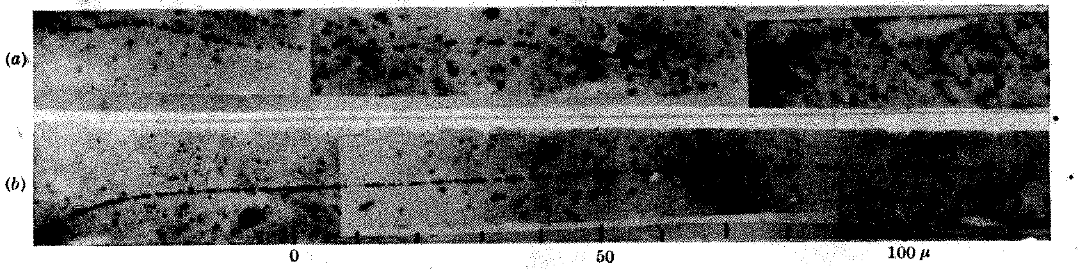

Fig. 1. (*a*) TRACK OF A MESON OF MASS 250 ± 50 m_e COMING TO REST IN THE EMULSION. (*b*) TRACK OF A PROTON FOUND ON THE SAME PLATE

Unfortunately, this work was interrupted by the War and only resumed a few months ago.

We have recently been using the new Ilford *C*2 emulsions of thickness 40 μ. In some three square centimetres which have been examined, fifteen long tracks due probably to protons of energy 10–20 MeV., a track of length 180 μ which appears to be that of a slow meson coming to rest in the emulsion, together with a star of eleven charged particles have been found. Cloud chamber observations show that about one slow meson should be observed per eight slow protons[5], in agreement in order of magnitude with one per fifteen obtained with this plate.

A photograph of the meson track is shown in Fig. 1 *a*. It can be seen that the scattering along its length is appreciably greater than along an equal length of proton track shown in Fig. 1 *b*. This fact affords an approximate method of determining the mass of the meson[3]. The observed scattering is consistent with that of a particle having a mass of about 200 m_e, where m_e is the mass of an electron. A better value may be obtained from a second method which involves counting the number of developed grains per unit length of the track and comparing the results with similar measurements made along the proton track shown in Fig. 1 *b*, having a total length of 1040 μ in the emulsion. The number of grains *n* per 15 μ of track were counted, and a curve of *n* against range in the emulsion was plotted for each particle. The residual range of each particle was found from the curve for points having the same value of *n* (that is, when the two particles have the same velocity). This gives a value for the mass of the meson of 250 ± 50 m_e, but the actual value is inevitably subject to large statistical errors unless a large number of tracks are available for measurement. It is not possible to say whether or not the meson decayed with the emission of a β-particle, because an electron having energy equal to half the rest-mass energy of the meson (that is, ~ 50 MeV.) would leave no distinguishable track in the emulsion.

A single photograph of the star is shown in Fig. 2. The measured length of each track is given using the notation used by Powell and Occhialini[4], that is, (*e*) signifies that the particle stops in the emulsion, (*s*) that it leaves the surface, and (*g*) that it passes into the glass. *A*, *E*, *G* and *I* are probably due to protons of energy 10–20 MeV., while *C*, *F*, *H*, *J* and *K* may represent the tracks of α-particles of energy ~ 10 MeV. *B* appears to be the track of a particle which is just heavier than an α-particle; *D*, on the other hand, represents the track of a much heavier particle. Assuming that the star represents the disintegration of either a silver or bromine atom, these particles should be accompanied by about ten or twelve neutrons, and we estimate that the total energy given to the nucleus by the incoming particle is of the order of 400 MeV. The proton and neutron intensities at sea-level are very weak, while fast negatively charged mesons make up about 35 per cent of the total radiation. Thus, this star may be another example of meson capture by a nucleus.

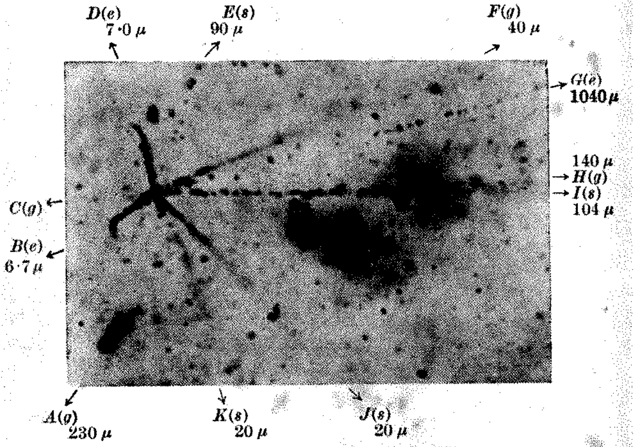

Fig. 2. A COSMIC RAY STAR FOUND IN ILFORD *C*2 EMULSION EXPOSED AT SEA-LEVEL

In conclusion, we wish to express our gratitude to Prof. R. M. Davies for many helpful discussions, to the heads of the Departments of Botany and Zoology for the loan of microscopes, and to Dr. C. F. Powell of the University of Bristol for bringing to our notice the new Ilford emulsions.

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April 8.

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[5] Williams, E. J., *Proc. Roy. Soc.*, A, **172**, 194 (1939).

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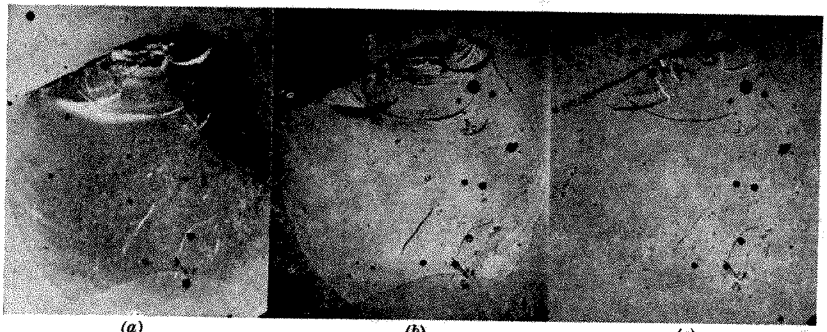
A Variable Phase-Contrast System for Microscopy

PHASE-CONTRAST effects occur when the paths of the dioptric and diffracted rays between object and image differ sufficiently to produce some degree of interference. Were it possible to polarize the diffracted rays and dioptric rays at right angles to one another, a path difference could be introduced by passing them through a birefringent screen, the refractive index of which, being different for two perpendicularly polarized rays, would produce the



(a) (b) (c)

GLASS FRAGMENT IN GLYCOL PHTHALATE, MAGNIFICATION 25. (a) BRIGHT FIELD EFFECT WITH PHASE CONTRAST. (b) DARK FIELD EFFECT WITH PHASE CONTRAST. (c) APPEARANCE WITHOUT PHASE CONTRAST

effect of different optical thicknesses accordingly. Such a screen might be a mica plate causing a fixed difference of a quarter of a wave-length, or a compensator of the Babinet–Soleil type producing a variable difference.

Experiments have been carried out to test the possibilities of a variable phase-contrast system based on this principle. To reduce constructional difficulty in the initial stages, a simple arrangement was used, axial plane polarized light being employed with a 1-in. objective, at the back focus of which was mounted a mica retardation screen. This consisted of a quarter-wave plate having its central portion cut out, rotated 90°, and cemented back again. Consequently, the 'fast' direction of the centre and the 'slow' one of the rim were aligned, and while the dioptric rays from the specimen were focused in the central portion, the diffracted rays passed through the periphery. Thus the dioptric rays could be advanced by a quarter wave-length with respect to the diffracted rays, or, by turning the disk 90°, retarded by the same amount.

The accompanying photographs were taken through a retardation screen of 'Cellophane' built up in a similar way, but with an angle of about 45° between the 'fast' axes of the central part and the rim. By adjustment of the analyser, the dioptric ray can be weakened as desired, and by rotation of the disk relative to the polarization plane the appearance can be varied in the manner shown. The object, a fragment of glass ($n = 1 \cdot 54$) mounted in glycol phthalate ($n = 1 \cdot 53$), was chosen for its intractable nature, and the absence of double refraction checked.

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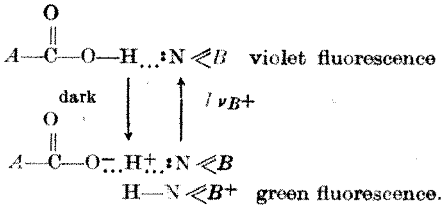
Proton Transfer between Organic Molecules Caused by Light

PROTON exchanges between acidic and basic organic compounds in solutions take place spontaneously according to the relative proton 'affinities' of the partners. The possibility of a proton transfer against the thermodynamic potential under the action of light seems not to have been demonstrated by a clear-cut experiment. In an investigation of photochemical reactions of organic compounds at low temperatures, we were able to show such an effect.

For the observation of a proton transfer without the intervention of a solvent, both components were sublimed *in vacuo* on to a cooled surface as a thin film in which a perfect mixture of the acidic and basic molecules was thus achieved. The experimental arrangement used was similar to that previously described[1]. As proton donors we chose easily sublimable crystalline organic acids, such as oxalic, benzoic, salicylic, succinic, terephthalic acids. As proton acceptor we used acridine, the well-known fluorescent indicator of pH in aqueous solutions, because the violet fluorescence of its neutral molecule is transformed into a bright green fluorescence in an acidified solution when this molecule incorporates a proton, being transformed into the acridinic cation with a corresponding change in the absorption and fluorescence spectra. This sharp change in the colour of the fluorescence was used here to detect the detachment of the proton from the acridinic cation under the action of light.

When both components condense from the vapour phase on to the surface kept at – 180° C., the close association of the acid with acridine will clearly lead to the formation of hydrogen bonds between the partners, as shown in the upper line of the diagram below, where the acid is designated by A, the basic molecule of acridine by B, their main groups being explicitly shown. At – 180° the violet fluorescence of the neutral acridine molecule rapidly changes, on standing, to a green fluorescence, this process being extremely rapid at room temperature. As can be judged from the position of the maximum in the fluorescence spectrum, this green fluorescence belongs to the acridinic cation, formed here at the cost of the proton detached from the acid (see lower part of the diagram). This process does not need any activation by light and occurs in a purely thermal way, equally well in the dark, as shown by the arrow pointing downwards. In all cases the fluorescence was excited by filtered ultra-violet radiation of the mercury lines at 366 mμ.


A—C(=O)—O—H...:N⋞B violet fluorescence
dark
hν_{B+}
A—C(=O)—O⁻...H⁺...:N⋞B
H—N⋞B⁺ green fluorescence.

Now, when the sublimated, composite, green fluorescing film is exposed for a short time to ultra-violet light of shorter wave-length in the range of the second maximum in the absorption spectrum of the acridinic cation (about 250 mμ), the fluorescence of the exposed area assumes a violet colour with a spectrum characteristic of the acridine molecule (arrow pointing upwards). But if the short ultraviolet stimulation is cut off, this violet fluorescence gradually disappears, being replaced by the initial green one. The process can be repeated at – 180° many times without any indication of an irreversible change. We infer from this experiment that absorption of light by the acridinic cation has activated the N—H bond and effected the detachment of the proton with its simultaneous transfer to the acid anion in a kind of coupled predissociation (see diagram). An energetic coupling between the partners must necessarily be assumed, since for succinic and terephthalic acids even relatively long wave-lengths in the first absorption maximum (at 360 mμ) of the acridinic cation are photo-active for this process. This reversible photo-reaction cannot be duplicated by the application of heat.

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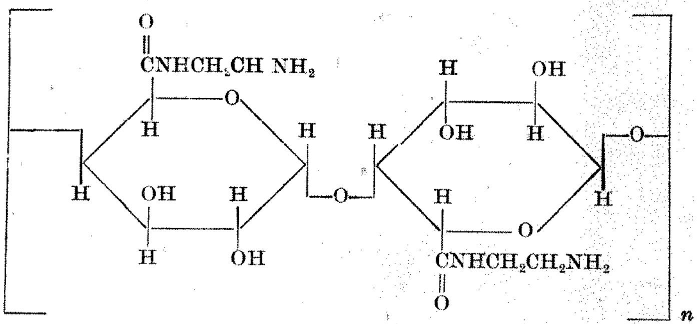
[1] Terenin, A., *Acta Phys. Chim. U.R.S.S.*, **12**, 617 (1940); **13**, 1 (1940); **14**, 566 (1941).

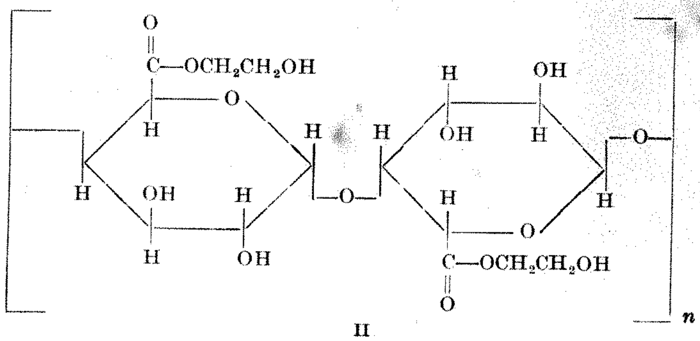
Derivatives of Pectic Acid as Models of Proteins

THE constitution and properties of pectic substances have been intensively studied[1]. Pectins, when reacting with the bifunctional formaldehyde under acidic conditions, have been found to form three-dimensional networks. This process takes place much more slowly than the corresponding reaction with polysaccharides containing primary hydroxyl groups (for example, lichenin). An accelerated reaction of pectic substances with formaldehyde may be obtained by using the mono-glycol ester of pectic acid (I) instead of the natural methyl ester. The glycol ester is easily produced[2] by treating pectic acid with ethylene oxide. A greater reactivity with formaldehyde, even under neutral conditions, would be expected upon the introduction of primary amino-groups into the pectic acid molecule.



I

Carson[3] described a simple method for the preparation of n-alkyl-amides of pectic acid by the reaction of their methyl esters with primary aliphatic amines. We have studied similar reactions with aliphatic diamines. Thus an amide of the following structure (II) was prepared by the action of ethylenediamine on the glycol ester of pectic acid (totally esterified):



II

A complete conversion of ester to amide groups produces bases of high molecular weight, every link of the chain molecule carrying a branch with a primary amino-group at its end. The aqueous solution of this macromolecular substance is found to produce a gel easily when formaldehyde is added. These bases form insoluble salts with high molecular weight acids. Similar to the polyethylenimines[4], these ethylenediamine derivatives of pectic acid precipitate pectic acid itself.

If the conversion of ester to amide groups is incomplete, or if the amides formed undergo a partial hydrolysis, derivatives of pectic acid with a structure similar to that described above but containing a certain percentage of free carboxyl groups are obtained. In this case every chain molecule carries acidic carboxyl as well as basic amino-groups. These macromolecules possess a dipolar ionic structure, and in many respects show properties similar to those of proteins; for example, coagulation or minimum viscosity at the isoelectric point. Water-insoluble substances of this type can be rendered soluble by the addition of acid, alkali or even neutral salts. In order to characterize these ampholytes, the methods of protein chemistry have proved to be suitable (Van Slyke method, Sørensen titration, etc.).

Ampholytes with any desired proportion of carboxyl- to amino-groups, as well as ampholytes of different size, can be produced from esters of polyuronic acids. It should be possible to relate their properties (solubility, viscosity, electrochemical and optical behaviour, etc.) to the fairly well-established structure of these macromolecules, whereas with proteins such a correlation encounters, for the time being, much greater difficulties.

Further investigations are in progress.

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[1] Summary in Hirst and Jones, "Adv. Carbohydrate Chem.", **2**, 235 (1946). Pallmann and Deuel, *Chimia*, **1**, 27 and 51 (1947).

[2] Deuel, *Experientia*, **3**, No. 4 (1947).

[3] Carson, *J. Amer. Chem. Soc.*, **68**, 2723 (1946).

[4] Kern and Brenneisen, *J. prakt. Chem.*, (2), **159**, 193 (1941).

Detection of End Groups in Polymer Molecules

THE radical theory of vinyl polymerization is confirmed by the identification of so-called catalyst fragments in the polymer molecule. The usual method is to purify the polymer by repeated re-precipitation and to use a catalyst containing an easily identifiable element. Thus when tribromobenzoyl peroxide has been used as the catalyst and the molecular weight of the product is not too high, it is possible to identify bromine in the polymer after repeated purification[1].

A method has now been found by which the presence of an end group in styrene polymerized with sodium sulphite[2] is readily demonstrated irrespective of the molecular weight and without any special purification of the polymer. The radical in this case is monothionic acid, so that every polymer molecule is equivalent to an acid of very high molecular weight. When 1,000 ml. of a 0·2 per cent solution of such polymer in benzene is mixed in a gently rotating bottle with 10 gm. of solid caustic potash pellets, the viscosity of the solution gradually increases to a maximum of approximately twice its initial value over a period of perhaps 50 hours. With a 0·4 per cent solution the viscosity increases several times, while with a 0·05 per cent solution the viscosity is scarcely changed. By the addition of a standardized solution of hydrochloric acid gas in benzene, it is possible to titrate the potassium salt of the polymer by continuous determination of the viscosity. With the first small addition the viscosity remains unchanged, and with further addition it falls rapidly to a constant value which is unchanged even after the addition of a considerable excess of acid. The initial flat portion is thought to be due to traces of salts of acids of low dissociation constant which must first be neutralized before the salt of the polymer is attacked. The calculation of the number average molecular weight from end-group titration in this way, therefore, necessitates some knowledge of the dissociation constant. Assuming that the dissociation constant of polystyrene acid is equal to that of hydrochloric acid under the same conditions, then a polystyrene sample having a specific viscosity of 0·66 at a concentration of 0·1 per cent in benzene gave an equivalent weight of 32,000 by viscometric titration. For an exact interpretation the effect of surface adsorption in such dilute solutions would need consideration.

The alkali-treated polymer solution gives a specific viscosity/concentration curve which cannot be extrapolated to zero concentration with any certainty, whereas the polymer acid under the same conditions is more nearly linear, which gives further light on the Staudinger molecular weight rule.

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[1] Price, C. C., and Tate, B. E., *J. Amer. Chem. Soc.*, 65, 517 (1943).

[2] The polymerization of styrene with sodium sulphite is described in B.P. 582134 (Sully).

Misuse of 'Deduced Ratios' in the Estimation of Median Effective Doses

Dragstedt and Lang[1] wrote: "It seems to us obvious that a rabbit that died from 100 mgm. would have died of any higher dose and one that survived from 150 mgm. per kilogram would have survived from any lesser dose", and tabulated their "mortality percentages" as deduced according to "this rationale" from experienced ratios at the various doses. Behrens[2], with a similar idea, pointed out its limitations: "Unter der Voraussetzung, dass es sich um ein stetiges Kollektiv handelt, dass in den einzelnen Gruppen gleichviel Tiere angesetzt werden [or percentages in place of experienced effect ratios be used] und dass die Gruppenabstände nach beiden Seiten [of the expected median dose] gleichgross sind (arithmetische Reihe [elsewhere he correctly advocates a geometric progression]), ist zu erwarten, dass die Gesamptzahl der bei niederen Dosen Gestorbenen gleich ist derjenigen der Überlebenden bei höheren Dosen vom erwarteten Wert aus betrachtet. Selbstverständlich müssen wir die gesamte Ausdehnung unseres Kollektives mit den Gruppen erfassen." Behrens pointed out that the deduced ratio at a given dose is not the mortality ratio except at the value 1/2; that the ratios deal with areas on, rather than with ordinates of, the cumulative frequency curve.

Burn[3] briefly outlined the procedure and gave an example from Behrens, but did not mention the requirements for legitimate use, and, like Dragstedt and Lang, spoke of the deduced ratios as (deduced) mortality ordinates. Following such easy examples, many workers (including myself, though I was fortunate enough to discover the error before publication), have treated the ratios as mortalities at a given dose, with asymmetrical and/or non-geometric dosage schedule, unequal numbers of animals at dose-levels, and/or incomplete coverage of the mortality range (from high probability of no effects at one end to that of 100 per cent effects at the other). The consequences, apparent with some experimentation on log dose-probit charts, are more or less bias in the estimated median dose, and, in calling the ratios ordinates of the cumulative frequency curve, distortion from normality and reduction of *apparent* inter-animal dispersion. The bottom of the pitfall is thus attained when one attempts to estimate, in terms of the deduced ratios, the standard error of the so-deduced median dose[4]. The error is underestimated.

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March 31.

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[1] *J. Pharmacol. and Exper. Therap.*, 32, 215 (1927–28).

[2] *Arch. f. exper. Path. u. Pharmakol.*, 140, 237 (1929).

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The *Plesianthropus* Skull

DR. R. BROOM's account[1] of the new *Plesianthropus* skull makes it possible to take another step towards assigning to this form the place it occupies in the Primate series. His Fig. 2 shows clearly that the lacrimal and the ethmoid articulate over a wide area in the orbit. Possibly, the sphenoid and ethmoid articulate superficially in the anterior fossa (Fig. 1), although it is very difficult to accept Broom's hypothetical median part of the suture line as being correctly placed. In both cases the likeness with the Asiatic rather than with the African anthropoids is noted by Broom; but he makes no mention of the condition of the typically simian maxillary–premaxillary suture present on the face. The features that Broom has already described appear to verify the dictum of Klaatsch that "the less an ape has changed from its original form just so much the more human it appears", and perhaps agreement could be reached by assuming that *Plesianthropus* is a primitive and generalized anthropoid ape that has not attained to all the specializations characteristic of the modern apes, and is therefore nearer to the basal stock of the Primates from which man arose.

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June 13.

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[1] *Nature*, 159, 809 (1947).

ACQUIRED RESISTANCE TO PALUDRINE IN *PLASMODIUM GALLINACEUM*

Acquired Resistance and Persistence after Passage through the Mosquito

ACQUIRED drug-resistance is well known in trypanosomes and bacteria; but hitherto there have been only four accounts of this phenomenon in experimental work upon malaria. The Sergents[1,2], and Kritschewski and Rubinstein[3], claim to have induced resistance to quinine in *Plasmodium relictum*, though the Sergents' claim is based on one case only. Kritschewski and Halperin[4] state that the quinine-resistance sometimes, though not invariably, persisted after cyclical passage through *Culex pipiens*. Acquired resistance to plasmoquine and quinine was described by Nauck[5], and to plasmochin by Fulton and Yorke[6] in blood-inoculated strains of *P. knowlesi*.

Paludrine (No. 4888, N^{1}-*p*-chlorophenyl-N^{5}-*iso*propylbiguanide), which was recently developed by Imperial Chemical (Pharmaceuticals), Ltd., is very active against avian[7] and against human malaria parasites[8,9], and promises to be a valuable drug in the treatment of malaria of man[10].

We have produced a forty-fold increase in resistance to paludrine in a strain of *Plasmodium gallinaceum* in chicks. In August 1946 we began to treat a normal strain of *P. gallinaceum*, passaged intravenously through chicks every second or third day, with the largest dose of paludrine hydrochloride (0·025 mgm.), which was without effect upon the parasites when given over a long period. Throughout this paper the doses are expressed in milligrams per 20 gm. of body weight of bird. After such treatment for a month, it was found that the parasites would tolerate a daily dose of 0·05 mgm. Thereafter the dose was gradually increased, as resistance to the drug developed, until after four and a half months parasites normal in appearance were developing in chicks receiving two doses daily each of 1·0 mgm., which is the largest dose that the host will tolerate.

The intensity of infections produced by standard inocula (50,000,000 parasites per chick) of the paludrine-resistant strain, in chicks receiving doses of paludrine ranging from 0·1 to 1·0 mgm. twice daily for three and a half days, was compared with similarly treated infections of the normal strain. Heavy infections were produced by the paludrine-resistant strain, whereas the development of the normal strain was inhibited completely.

The paludrine-resistant strain was tested for resistance to mepacrine hydrochloride and 4430 (N^{1}-*p*-chlorophenyl-N^{5}-methyl-N^{5}-*iso*propylbiguanide) acetate. In the minimum doses effective against the normal strain, the paludrine-resistant strain was not resistant to mepacrine, but showed definite resistance to 4430 (Table 1). Thus the resistance to paludrine is not specific but extends to the methyl homologue of the compound.

Attempts, extending over six months, to induce resistance to mepacrine in a normal strain of *P. gallinaceum* by the method used to produce paludrine-resistance failed; but after eight months treatment with pamaquin (= plasmochin) a normal strain of *P. gallinaceum* became resistant to the minimum effective dose (0·08 mgm.) of that drug.

TABLE 1. COMPARISON OF INTENSITY OF INFECTION OF PALU
RESISTANT AND NORMAL STRAINS

Normal strain	Paludrine-resistant strain	Normal strain	Paludri resistant s
Untreated birds		Mepacrine, 0·64 mgm.	
1076, (3)	1030 (2)	11 (5)	3 (
Untreated birds		No. 4430, 0·4 mgm.	
800 (2)	843 (2)	0 (4)	640 (4

The intensity of infection is expressed as the average numl parasites per 500 erythrocytes in groups of 2–5 birds. The n of birds in each experiment is given in brackets.

Exo-erythrocytic parasites similar in appear to those produced in normal infections were for by the paludrine-resistant strain.

Fairley and his co-workers[10] have shown that development of *P. falciparum* and *P. vivax* is inhibi in the mosquito if paludrine, even in small quantit is present in the infected blood. Such inhibition d [redacted] not occur in the paludrine-resistant strain of *gallinaceum*. Thus four batches of *Aëdes œgy* were allowed to gorge upon chicks infected with t [redacted] strain of *P. gallinaceum* resistant to twice-daily do of 0·4 mgm. of paludrine. Although the chicks we undergoing treatment with paludrine and had receiv a dose of drug four hours previous to being bitte oocysts were numerous on the gut wall of the mo quitoes on the fourth day, and the salivary glan became heavily infected with sporozoites. The proved to be infective to chicks. The parasites whi developed in the sporozoite-inoculated birds re tained the resistance to paludrine (Table 2). Th stability of the paludrine-resistance was further teste after three and five mosquito passages withou intervening drug treatment. These passages covere a period of three months, and the results showed tha there was no loss in paludrine-resistance (Table 2).

TABLE 2. COMPARISON OF INTENSITY OF INFECTION OF PALUDRINE RESISTANT AND NORMAL STRAINS

	Untreated birds		Drugged birds	
Dose twice daily	Normal strain	Paludrine-resistant strain	Normal strain	Paludrine-resistant strain
	After 1 mosquito passage			
Paludrine				
0·4	1076 (3)	979 (2)	1 (5)	540 (5)
0·4	1001 (6)	903 (6)	0 (6)	466 (6)
0·4	1075 (3)	617 (3)	1 (6)	158 (5)
0·4	559 (4)	544 (5)	0 (4)	398 (5)
0·2				537 (6)
0·1*				720 (4)
	After 3 mosquito passages			
0·4	1240 (6)	685 (5)	0 (6)	268 (6)
0·2				451 (6)
	After 5 mosquito passages			
0·4	1344 (6)	862 (6)	1 (6)	398 (6)
0·2				784 (6)
0·1*				945 (6)

* Minimum dose effective on normal strain.
The intensity of infection is expressed as the average number of parasites per 500 erythrocytes in groups of 2–6 birds. The number of birds in each experiment is given in brackets.

Apart from Kritschewski and Halperin's observations, experiments upon acquired drug resistance have hitherto been made upon organisms in which a sexual cycle of development is not known. The persistence of paludrine-resistance in *P. gallinaceum* after transmission by the mosquito is therefore of particular interest, as a definite sexual cycle of development is involved. Whatever may be the mechanism which produces this resistance, whether it be the selection of favourable mutants or the gradual adaptation of the parasites to the drug, resistance so produced is maintained through at least five sexual cycles, and also persists after a long sojourn in an environment (the mosquitoes' tissues) entirely different from that in which it was evolved.

A detailed account of these results will be published later. We are indebted to Imperial Chemical (Pharmaceuticals), Ltd.; for the gift of the paludrine, 4430, pamaquin and mepacrine. The work has been financed by the Medical Research Council.

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Effects of Paludrine and Other Antimalarials

THE facility with which pathogenic protozoa and bacteria may acquire resistance to therapeutic agents, as a result of non-curative treatment of infections by these pathogens, is of profound significance both for the theory and for the practice of chemotherapy. The readiness with which trypanosome species may thus develop resistance to certain types of compound is well known; but malaria parasites in general have hitherto appeared singularly incapable of developing an acquired resistance, although a number of claims to have demonstrated this property have been made. Only one of these claims, that of Fulton and Yorke[1], referred to again below, can be incontrovertibly accepted.

Lourie[2] treated infections of *P. cathemerium*, in serial passage through canaries, with an intraperitoneal injection of 1 mgm. quinine hydrochloride every day for seventeen months, without producing quinine-resistance; similar treatment with 0·01 mgm. pamaquin (plasmochin) every day for nine and a half months failed to give rise to pamaquin-resistance. Fulton[3], working with *P. gallinaceum* in chickens, also failed to produce pamaquin-resistance by means of intermittent short courses of intensive treatment over a period of fifteen and a half months, and he suggested that the explanation may lie in the fact that the exo-erythrocytic forms, discovered by James and Tate[4], do not respond to treatment and therefore remain as a source of further pamaquin-sensitive erythrocytic forms. Fulton and Yorke[1] were able to produce pamaquin-resistance in *P. knowlesi* (in which exo-erythrocytic stages have not yet been demonstrated) in monkeys.

We have failed to produce resistance to quinine hydrochloride, mepacrine methanesulphonate, sulphadiazine, or 3349 (a forerunner of paludrine, see Curd, Davey and Rose[5]) in *P. gallinaceum*, in the course of intensive treatment of serially infected chicks, for periods extending over more than two years, as shown in the accompanying table (series 1 to 4). At the end of these periods the drug-treated strains proved to be as sensitive to the respective compounds as they were at the start.

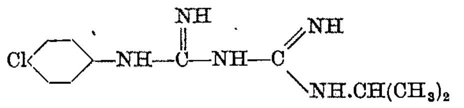
In the case of paludrine, however, a high degree of resistance appeared within about three months, in serially subinoculated and treated infections, in each of two experiments (series 5 and 6). In series 5 the infections were treated with doses of the order of the minimum effective for the normal strain, and in series 6 with doses in the region of the maximum tolerated by young chicks. The first indication of resistance in series 5 appeared two and a half months from the start (after a total of 54 doses of 0·25 mgm. per 50 gm. body-weight), and a month later, that is, at the end of the three and a half month period quoted in the table, infections were completely resistant to a course of seven doses of 0·25 mgm. in three and a half days. In series 6 a high degree of resistance—at least a tenfold increase—appeared suddenly at the end of the three-month period quoted in the table, a period which includes one month during which no treatment was administered. Both strains were then subjected to more treatment, in further serially inoculated chicks (a further aggregate of 3·5 mgm. in eleven days for series 5, and 70 mgm. in one month for series 6). Infections with parasites of each of these strains were then compared with parent strain infections, in respect of the 'minimum effective dose', as defined and as determined by the technique of Davey[6]. By this measure, the parasites of series 5 appeared to be about twenty times, and those of series 6 at least twenty to forty times, as resistant to paludrine as parasites of the parent strain.

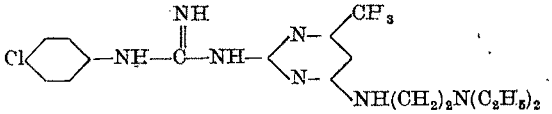
HISTORY OF DRUG TREATMENTS IN SIX SERIES OF *P. gallinaceum* INFECTIONS

Series	Treated with	Duration of treatment		Dosage (by stomach tube)			Result
		Total (months)	No. of successive passages	Size of each dose (mgm. per 50 gm.)	Total no. of doses	Aggregate dosage for series (mgm. per 50 gm.)	
1	Quinine	29	73	7·5	516	3,870	No acquired resistance
2	Mepacrine	27	69	10·0	438	4,380	
3	Sulphadiazine	27	44	25·0	500	12,500	
4	3349	28	73	10·0	483	4,830	
5	Paludrine	3½	16	0·25	75	19	High degree of acquired resistance
6	,,	3	11	5·0 (occasionally 2·5 or 0·25)	32	119	

The paludrine-resistant strain of series 6 was found to be normally sensitive to quinine, mepacrine, sulphadiazine, and 3349. The absence of acquired resistance to 3349, on the part of the paludrine-resistant strain, coupled with the failure to produce resistance by prolonged exposure to 3349, is of special interest in view of the similarity between paludrine and 3349 in respect of prototropic possibilities, stressed by Curd, Davey and Rose[7] as associated with antimalarial activity in compounds of this general type.

The paludrine-resistant strain was found to be fully resistant also to 4430[7], a close analogue of paludrine, and both these compounds lack the pyrimidine ring of the earlier prototypes of Curd, Davey and Rose which included 3349. This suggests that it may be the pyrimidine ring which determines the widely divergent behaviour of 3349 and paludrine in respect of acquired drug resistance, an interpretation which is further supported by the fact that the paludrine-resistant strain has been found to be normally sensitive also to 3502[5], a pyrimidine analogue of 3349.


Paludrine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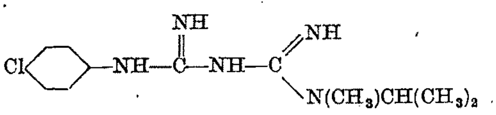
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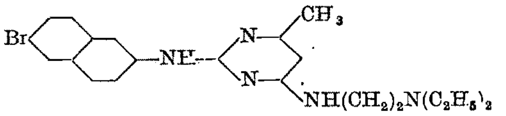
3502

About a month after the last dose of paludrine to the resistant strain of series 6, chicks infected with the strain were fed to *Aëdes ægypti*, which became heavily infected. There was clearly no impairment of transmissibility of this strain through mosquitoes, and when tested after mosquito-passage the strain was found to be as resistant to paludrine as before.

We are obliged to Dr. J. D. Fulton and Dr. J. W. S. Macfie for their co-operation in the early stages of this work, which was aided by a grant from the Medical Research Council. We are also grateful to Imperial Chemical Industries, Ltd., for supplying some of the compounds used. Full details will be published in the *Annals of Tropical Medicine and Parasitology*.

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PHYSIOLOGY OF PATTERN FORMATION IN MALE AND FEMALE FEATHERS OF BARRED PLYMOUTH ROCK FOWLS

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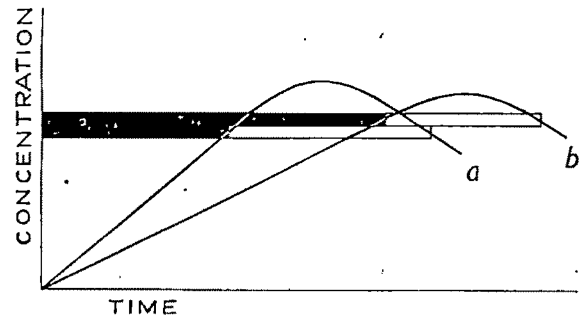
ONLY very recently was I able to read Nickerson's paper[1] on barred pattern formation in chicken feathers. Nickerson's experimental analysis by means of melanophore transplantation according to H. B. Willier's technique, with other experiments and observations, demonstrates that the barring rhythm is determined by the melanophores themselves rather than by their reaction to some extrinsic rhythm or pre-existing pattern in the epidermal substratum of the feather germ (the latter view was maintained by Henke[2]). Thus barring is determined not only by the action of the genes independently in each follicle, as I supposed[3], but also by a rhythm inherent in the melanophores of each follicle. Furthermore, the suggestive hypothesis is put forward that "the barring rhythm is controlled by the action of melanophores through the medium of some diffusible substance which is capable of inhibiting the formation of pigment by melanophores present in the subjacent white regions of the developing feather germ"[1]. Such an interpretation fits well, as Nickerson points out, with the correlation that I have demonstrated between pattern characters and rate of growth of the feather, including the negative correlation between width of the white bar and growth-rate.

I should like now to direct attention to another point which has not been discussed by Nickerson, namely, the sexual dimorphism of pattern. The structural differences in feathers of certain tracts (for example, neck, saddle) between cock and hen are dependent on sex hormones[4] just as in many other breeds of fowl; but even in structurally identical feathers (for example, flights, breast feathers, etc.) a sexual dimorphism exists which has been analysed by Agostini[5]. The width of double bar (black plus white) is smaller in the male than in the female, both in juvenile and adult plumage (average ratio on breast feathers *c.* 0·78–1). The width of the black bar with respect to white is also smaller in the male feather: in the adult plumage (breast) of the cock the black bar comprises, on an average, 50 per cent of the double bar, while in the hen it comprises as much as 70 per cent. In other words, the male has a smaller double bar and a larger white bar than the female. These differences are statistically valid[5]. They do not depend on sex hormones, because castration, ovariectomy[5] and transplantation[3,6] do not alter them. Therefore, they are most probably directly determined by genetical constitution. Since barring is a sex-linked character and since the male is heterozygous in birds, one can suppose that such a phenotypic effect might be due to the presence of two doses of the *B* gene in the male and only one in the female[5]. How does this interpretation fit in with Nickerson's hypothesis?

Before testing this point, it must be emphasized that the different width of bars and different white/black ratios cannot be determined by different growth-rates in homologous feathers of male and female. I did not find any substantial difference in rate of



AVERAGE WIDTH OF THE BLACK AND WHITE BARS IN THE FEMALE (*above*) AND MALE (*below*) ANTERIOR BREAST FEATHERS OF BARRED PLYMOUTH ROCKS. HYPOTHETICAL CURVES OF THE CONCENTRATION OF THE PIGMENT-INHIBITING SUBSTANCE IN THE MALE (*a*) AND FEMALE (*b*) FEATHER GERMS AND THEIR THRESHOLD VALUES ARE ADJUSTED TO FIT THE ACTUAL WIDTH OF BARS

growth between homologous flights of a cock and a hen with very marked sexual dimorphism of the pattern[3]. Fluctuations in growth-rates of feathers of the same tract certainly do occur in different individuals, and possibly a small consistent sexual difference also exists. Unfortunately, I have not been able, for a long time, to work with chickens and therefore I have not been able to collect sufficient data relating to this point. In any event, from published and some unpublished data I also find that the differences in growth-rate between male and female breast feathers are not sufficiently high to account for the differences of pattern. In fact, one can calculate, starting from the male pattern, the growth-rate expected in order to account for the width of the female double bar. Pooling together the figures for three cocks and two hens, the average growth-rate of the hen's anterior breast feather should be, in order to agree with the width of pattern, 2·022 ± 0·0265 mm. per day, while it is actually 1·865 ± 0·0243; in the hen's posterior breast feather it should be 2·340 ± 0·0258, while it is in fact 2·160 ± 0·0381. The differences between the expected and observed figures are: 0·157 ± 0·0359 and 0·180 ± 0·0460, that is, they are significant. Therefore, I think that a difference in rate of growth, even if statistically ascertained, could not explain the different width of the double bar, to say nothing of the fact that the higher the rate of growth, the greater should be the proportion of white to black[3], which is just the contrary of what occurs.

The larger proportion of white in the male feather is easy to understand on the above assumption. As has often been pointed out, the genetical and physiological evidence is quite convincing that the *B* factor acts as a rhythmic suppressor of pigmentation: the positive effect, in barring, is inhibition of pigmentation, and Nickerson's hypothesis is in line with this view. Thus a higher dose of *B* gene (*BB* genotype in male) would presumably form a greater amount of the inhibiting substance, which would interrupt pigment formation for a longer time (about 1·3 to 1 is the male to female white bar ratio, absolute width, in the breast feather) than the *BO* female genotype.

It is more difficult to see why the width of the double bar should be larger in the hemizygous sex. Supposing that a threshold of a concentration of the inhibiting substance must be reached for the melanophores to react, and that the rate of formation of the substance is in some way proportional to the dose of *B* gene present; in the *BO* genotype the melanophores may work for a longer time (about 1·84 to 1 is the female to male black ratio, according to Agostini's average data) in forming pigment, before the inhibiting substance reaches the threshold concentration (hence the greater width of black bars). Once it is reached, the elimination of the substance should take place more rapidly (because of its lower total concentration), hence the absolute narrowness of the white bar. Since the black bar alone is, on the average, 1·84 times wider in male than in female breast feather, even a relatively short duration of the 'white' phase will bring about a greater width of the total bar in the female. The process might be represented in a diagrammatic way as in the accompanying illustration, where the relative width of black and white bars in male and female feathers are taken from the mean values of Agostini's data, while the curves of concentration of the inhibiting substance are, of course, entirely hypothetical and roughly adjusted to fit the actual morphological data.

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BIOLOGICAL INVESTIGATIONS IN THE AEGEAN SEA

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As is well known, the eastern Mediterranean has been far less biologically explored than the western. It was therefore a very welcome occasion to spend several months (1943) in the Island of Rhodes (Aegean Sea) and carry out there a series of researches, the main result of which has been to add a number of species to those previously found and recorded. Knowledge of Aegean animals was first improved by E. Forbes about a century ago. In 1926 a group of Italian zoologists investigated the shores of Rhodes and neighbouring islands; other scattered data are to be found in various scientific papers, such as those concerning the famous *Thor* expedition. New and careful investigations are desirable for both an exact understanding of geographical distribution, variations and migrations of Mediterranean species and for ascertaining the spreading of those which have immigrated from the Red Sea through the Suez Canal: it is certain that some of them have reached the Aegean Sea, following the main current along the coasts of Syria and Asia Minor.

Of such zoological groups as Porifera, Cnidaria, Echinodermata, Nemertea, Tunicata and fishes no collections had hitherto been made in Rhodes and nothing is actually known. The marine fauna does not seem to be a very rich one; both species and individuals appear relatively scarce and it is improbable that this may be due to lack of proper researches. Steepness of submarine soil and frequent roughness of sea, consequent on almost continuous and violent winds, are probably responsible for this scantiness of life. General physiognomy, however typically Mediterranean, differs somewhat from that of the western shores of this Sea, as well as from that of its more northern parts; a number of species, for example, fishes, are peculiar to warm waters. Field work (hindered by war conditions) on various types of sea-bottom and sea-shore has revealed some noteworthy biocænosis. The predominance of *Cardita sulcata*, a lamellibranchiate molluscan, along the sandy beaches was already known; a peculiar association of *Asterina* and *Chiton* under the stones was now noted on rocky bottom in the harbour, with plenty of seaweeds; various other invertebrates were sharing the same habitat. Calcareous sponges, sea-anemones (*Anemonia sulcata*), two species of Nemerteans, free and sedentary Polychæta, Bryozoa (among them *Zoobotryon pellucidum*) and Ascidians were found in the harbour of Rhodes city and its neighbourhoods. *Actinia equina* seems to be missing, but on the opposite shores of Anatolia a good number of fine specimens were found. In shallow water during summer *Aplysia* was plentiful and grazing among seaweeds; a good series of other Mollusca were collected, too. Among other species were *Tethys leporina* and two different *Octopus*. Colonies of *Pyrosoma* and some Hydromedusæ were the only pelagic animals that could be obtained. Twenty species of Echinoderms were gathered: among them *Tethyaster*, *Ceramaster* and *Centrostephanus* were quite common in rather deep water, more or less distant from the shore. Crustaceans were fairly abundant, and among the largest Malacostraca *Squilla mantis*, *Scyllarides latus*, *Maia squinado*, *Calappa granulata* and *Dromia vulgaris* do not appear to have been previously noticed, as well as *Pagurus striatus*, a common dweller of large shells of *Cassis sulcosa* and *Murex trunculus*.

Fishes were particularly looked for, and collected species amounted to 116, of which six were Plagiostomia. Fishermen are few, and their work even in normal times is not a profitable one. The cause is to be found both in scarcity of plankton, that does not foster a rich fish-life, and in the nature of the sea-bottom, that forbids using some fishing technique otherwise advantageous. Ambiental conditions are unfavourable to fishes the life of which is largely dependent on development of continental shelf, as are Heterosomata, of which four species only were obtained. Shoals of migratory fishes (Scombroids, etc.) coming from the Black Sea or going there appear near Rhodes, but cannot support fisheries on an industrial scale. As a whole, these animals are much more numerous along the coasts of Asia Minor. Large sea-basses, mullets, red mullets, hakes and some sparoids were most frequently observed to be sold. This fish fauna shows a rather tropical character, that is stressed not only by such chiefly tropical families as Labroids and Carangoids or genera such as *Sardinella* and *Sparisoma*, but also by the presence of Red Sea immigrants. Only one of these, *Siganus rivulatus*, had previously been found in Aegean waters. Two other species may now be added—*Hemirhamphus marginatus* and *Monacanthus setifer*, the latter hitherto found only in Palestine. Apart from some species such as the small ray (*Raia radula*), that are more or less localized and the recognition of which is therefore interesting, four species, of which a single specimen was found in Rhodes, deserve particular mention. *Lobotes surinamensis*, a percoid, and *Remilegia australis*, a remora (sucking-fish), are tropical species of which we had but one Mediterranean record: the former was captured in Palermo (1875), the latter in Trieste (1881). *Scyris alexandrinus*, a form of deep-bodied carangoid, seems to be rare and until now was reported only from North Africa and Syria. *Gobius thori* is a little goby of which only the type specimen, collected by the *Thor* near Tenedo (northern Aegean Sea) many years ago, was known.

All this material was unfortunately lost, but all notes and drawings were fortunately preserved, so that it has been possible to deal with it particularly in separate papers, that will appear—it is hoped—as soon as printing difficulties will allow.

RADIOCHEMISTRY IN BRITAIN

OPENING OF THE LONDONDERRY LABORATORY AT DURHAM

GREAT BRITAIN was in the forefront of original research on the chemistry of the radio-elements so long as Frederick Soddy, after his return from Montreal, was devoting his activities to this field. Much of the experimental material which led to his conception of isotopy was collected in his laboratories in Glasgow by A. Fleck; the first thorium-lead was prepared there and its atomic weight determined; and protoactinium was discovered by Soddy and Cranston in Aberdeen simultaneously with Hahn and Meitner in Berlin-Dahlem. No chemical laboratory in Great Britain, however, has followed up the tradition, so that from about 1918 on, the centres of radiochemical research were the Laboratoire Curie in Paris, and the Radium Department of the Kaiser Wilhelm Institut für Chemie at Dahlem, under Otto Hahn. How important their work was may be seen from the one fact that the discovery of the fission of uranium was an achievement to which the systematic study of the chemical products of the uranium irradiation was bound to lead, and to which the Paris laboratory had already come very close when Hahn and Strassmann's fundamental paper appeared. In Britain no corresponding work was undertaken, in spite of several physicists being greatly interested in the problem.

The need for a revival of radiochemistry was keenly felt during the Second World War, when the military and economic possibilities of the use of atomic energy had been recognized, and in Montreal a joint British–Canadian Government team, first under the directorship of Dr. H. Halban, and later under that of Prof. J. D. Cockcroft, did research work on uranium fission. The chemistry division of that team, built up during the years 1943–45 under Prof. F. A. Paneth, comprised finally more than thirty graduates, many of whom had been recruited in Britain.

It would have been deplorable if at the end of the War still no British university had shown interest in the study of radiochemistry. Fortunately, the University of Durham, with the support of the University Grants Committee, found ways and means of building a laboratory in which radiochemical specialists can carry out their researches and, at the same time, train young chemists in the particular techniques which will enable them to collaborat with the departments of nuclear physics in univer ties and Government establishments, and also w biologists interested in the use of radioactive tracers. The laboratory, designed by Dr. E. Glueckauf and Mr. L. Gradon, consists of two modest one-story buildings near the main Science Laboratories, one equipped for the chemical treatment of radioactive substances of low activities, the other for those emitting strong radiations.

This Laboratory—named after Lord Londonderry, chancellor of the University of Durham, who has personally contributed to the cost of its erection by a generous gift—was formally opened on June 4 by Viscount Portal of Hungerford, on whom the honorary degree of D.C.L. was conferred on this occasion. The ceremony was attended by Sir Wallace Akers, who during the War was director of the United Kingdom Government's atomic energy project; Dr. A. Fleck, Soddy's old collaborator; Dr. J. D. Cockcroft, now in charge of the Atomic Energy Research Establishment at Harwell; Dr. J. Guéron, of the Commissariat de l'Energie Atomique in Paris; and many other well-known men of science. Lord Portal, who after his brilliant R.A.F. career is now directing the Government's efforts towards the peace-time utilization of atomic energy, replied with a speech which dealt largely with the relationship of British universities to the State. We print below some extracts from Lord Portal's address.

The practice of the universities of Great Britain in honouring members of the fighting services with degrees is, in my humble opinion, a very sound one, quite apart from the personal pleasure it gives to the recipients. It tends to emphasize one of the clearest lessons of the late War, that to secure the greatest possible efficiency the fighting services must call to their aid, in peace as well as in war, all the best talent in civil life, and make full use in many different ways of the type of brain-power that is to be found in the universities rather than in the fighting services in peace-time. The closer you can draw the bonds between the universities and the fighting services, the better for the country.

Much of the special scientific work done in the War by, or under the guidance of, members of the staff of the University of Durham was of great importance, directly or indirectly, to the fighting services. Under such distinguished men as Profs. Curtis, Riley and Wager, Drs. Valentine, Richardson and Varley, and Mr. Cragg, problems ranging from camouflage to the case-hardening of steel; from air photography to agricultural pests; from hydrodynamics to the dehydration of food, were tackled with great success.

But to-day we are thinking mainly of radiochemistry, because this new Laboratory will be the first school in that subject to be formed in Great Britain, and the subject is one of very great importance if the peaceful uses of atomic energy are to be fully developed. It is good news that the school is to be under the charge of so eminent a man as Prof. F. A. Paneth, whose reputation extends far beyond this country and whom we were all delighted to see honoured recently with the fellowship of the Royal Society. He and some of his associates from this University, Drs. Chackett and Musgrave, and Mr. Martin and Mr. Morgan, did valuable work in Canada during the War, and there is much for them to do here in the future. For without skilled radiochemists in adequate numbers, we shall not be able to develop fully the use of the radioactive isotopes which we hope will be of such enormous benefit to future research in medicine, agriculture and industry generally.

I hope you will not think it inappropriate if I conclude with one or two observations which are not strictly relevant to this occasion or to this University.

During the last year my work has brought me into close contact with many of the most eminent men of science in Great Britain. Perhaps it is a bit late for me to hope to make good the omissions of a classical education, but I can say with truth how enormously I respect these great men and the power and integrity of their brains, and how immensely helpful I have found their advice, even when I am unable to follow their calculations. In the course of my contact with them, and in reading what others have written, I have realized the depth of feeling which exists far and wide in the world of science about the responsibility of scientific men for the consequences of the discoveries they have made in the realm of nuclear fission.

Like the discovery of flying, this atom business is in many ways very awkward. I sympathize very much with the scientific men. It is perfectly true that the prospects for the good uses of atomic energy which are already foreseen, and for the discovery of others not yet foreseen, are at present gravely affected by international distrust and the resulting need for secrecy and strict Government control of the whole business. Secrecy is in itself a brake on progress, and if it has to be continued indefinitely it may well drive some good men in disgust to other lines of research where freedom is allowed and can do no harm. Government control, though it is absolutely necessary under present conditions, and perhaps always will be, means that the best brains in industry, particularly on the engineering and metallurgical sides which are every bit as important as the nuclear-physical side, are difficult to mobilize upon the problems of development.

No one could recognize all this more clearly than we officials who have to help to administer the law, but it really is no use pretending that conditions to-day are appropriate for the casting of all secrecy to the winds in the name of the freedom of science. What we can and will do is to try, consistently with our duty, to minimize the inconvenience caused by the restrictions and to interpret the will of Parliament in a liberal spirit.

I do not think that, on the long view, there need be any uneasiness about the British contribution to atomic energy, though the rate of progress is bound to be affected by the number of urgent things Britain has to tackle simultaneously at the present time. We may not have the volume of human and material resources that some other nations have, and the maintenance of a proper balance between research directed to the execution of a short-term programme and that required for the needs of long-term progress and training will always be a problem. But I do believe we have in Britain the quality of human genius which will before long put us in the very front rank. Quality is what we must bank on, and it is to the British universities that we must chiefly look to foster and maintain the quality of future generations of our scientists and engineers.

May I express the hope and belief of all who are here to-day that the Londonderry Laboratory will see long and useful service, and that the work done there will be outstanding in its contribution to the ultimate benefit of mankind.

FORTHCOMING EVENTS

Tuesday, July 1

Royal Society of Medicine (at 1 Wimpole Street, London, W.1), at 1.30 p.m.—Annual General Meeting.

Wednesday, July 2—Thursday, July 3

Irish Chemical Association (joint meeting with the Dublin Section of the Royal Institute of Chemistry, in the Department of Chemistry, University College, Upper Merrion Street, Dublin).—Colloquium on "The Industrial Utilization of Agricultural Products and of Seaweed".

Wednesday, July 2

At 10.30 a.m.—Prof. J. L. Simonsen, F.R.S.: "Agricultural Products and the Chemical Industry"; at 2.30 p.m.—Prof. J. B. Speakman: "The Production, Properties and Uses of Seaweed Rayon".

Thursday, July 3

At 10 a.m.—Prof. E. L. Hirst, F.R.S.: "The Utilization of Carbohydrate Products".

Friday, July 4

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. K. P. Oakley: "Geological Safari in East Africa".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Responsible Lecturer in Biology, and a Responsible Art Master, in the Municipal Technical College and School of Art—The Director of Education, Education Offices, Library Street, Blackburn (July 5).

Readership in Mining tenable at King's College, Newcastle-upon-Tyne—The Registrar, University Office, 45 North Bailey, Durham (July 5).

Head of the Department of Horticulture—The Principal, Yorkshire Institute of Agriculture, Askham Bryan, York (July 5).

Lecturer in Engineering Workshop Subjects, with special qualifications in Automobile Engineering—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (July 5).

Senior Assistant in Mechanical Engineering—The Principal, Harris Institute, Corporation Street, Preston (July 5).

Head of the Building and Civil Engineering Department—The Principal, Royal Technical College, Peel Park, Salford 5 (July 5).

Lecturer in the Engineering Department of the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (July 5).

Organic Chemist at Long Ashton Research Station—The Secretary and Registrar, The University, Bristol 8 (July 7).

Lecturer in Mechanical Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (July 8).

Head of the Electrical Engineering Department of the Rutherford College of Technology—The Director of Education, Education Offices, Newcastle-upon-Tyne (July 8).

Lecturer in Chemistry, a Lecturer in Physics, and a Lecturer in Mechanical Engineering—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (July 12).

Assistant Lecturers (2) in Physics—The Registrar, The University, Manchester 13 (July 12).

Professor of Physics at the Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 15).

Assistant Lecturer in Fuel Technology in the Department of Metallurgy—The Registrar, University College of South Wales, Cathays Park, Cardiff (July 15).

Chief Chemist (grade of Principal Scientific Officer or Senior Principal Scientific Officer), Scientific Officers or Senior Scientific Officers (Chemists and Physicists), and Technical Officers in the Testing and Dyeing and Finishing Departments—The Secretary, Wool Industries Research Association, Torridon, Leeds 8 (July 19).

Speech Therapist—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1 (July 19).

Chair of Physiology at Charing Cross Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (July 21).

Assistant Professor of Applied Chemistry (Organic), an Assistant Professor of Applied Chemistry (Inorganic), and Lecturers (4) in Organic or Inorganic or Applied Chemistry or Biochemistry, at the Industrial Chemistry Institute, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (July 31).

Professor of Theoretical Physics, an Assistant Professor of Physics, an Assistant Professor of Applied Mathematics, a Lecturer A of Applied Mathematics, and a Lecturer A of Experimental Physics, in the Faculty of Science, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (July 31).

Research Fellowship (Organic Chemist)—The Secretary, Institute of Child Health, Hospital for Sick Children, Great Ormond Street, London, W.C.1 (July 31).

Senior Lecturer in Mathematics in the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Lecturer in Phonetics—The Secretary, The University, Edinburgh (July 31).

Lecturer in Chemistry in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 1).

Assistant Lecturer in the Department of Embryology—The Secretary, University College, Gower Street, London, W.C.1 (August 1).

Junior Lecturer in Physics in Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 8).

Lecturer in Anthropology in the University of Cambridge—Dr. G. E. Daniel, St. John's College, Cambridge (September 20).

Botanist to the Empire Potato Collection, Cambridge—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1 (September 30).

Director of the Parasitological Laboratory, Baghdad—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.13725.

Head of the Mathematics Department—The Principal, Huddersfield Technical College, Huddersfield.

Lecturer in Physiology and Zoology—The Registrar, Technical College, Sunderland.

Lecturer in Chemistry (Grade I) in the School of Bakery—The Secretary, Royal Technical College, Glasgow.

Lecturer in Fuel Technology, and a Demonstrator (temporary) in the Department of Physics—The Registrar, King's College, Newcastle-upon-Tyne.

Lecturers in (*a*) Chemistry to B.Sc. standard, (*b*) Biology to Inter.B.Sc. standard, and (*c*) Mathematics, Pure and Applied, to B.Sc. standard—The Clerk, Northern Polytechnic, Holloway Road, London, N.7.

Lecturers (2) in Mathematics—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan.

Head of the Department of Chemistry—The Clerk, Northern Polytechnic, Holloway Road, London, N.7, endorsed 'H'.

Assistant Lecturer and Demonstrator in the Physics Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Lecturer in Agricultural Chemistry (Animal Nutrition) in the Faculty of Agriculture and Horticulture—The Registrar, The University, Reading.

Lecturer, and Assistant Lecturers (2), in the Department of Biochemistry—The Secretary, University College, Gower Street, London, W.C.1.

Technician (Grade A), and Technicians (2, Grade B), with special knowledge of hæmatology—The Medical Superintendent, Dudley Road Hospital, Birmingham 18.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Abstracts of World Surgery, Obstetrics and Gynaecology. Vol. 1, No. 1, January. Pp. ii + 70 + viii. (London: British Medical Association, 1947.) 4*s.*; 42*s.* per annum. [221

Abstracts of World Medicine. Vol. 1, No. 1, January. Pp. ii + 110 + xii. (London: British Medical Association, 1947.) 6*s.*; 63*s.* per annum. [221

The Examination of Colliery Ropes in Service. Reprint. Pp. 27. (London: H.M. Stationery Office, 1946.) 4*d.* net. [221

Water and Public Health. By W. Gordon Carey. (Twenty-eighth Streatfeild Memorial Lecture.) Pp. 24. (London: Royal Institute of Chemistry, 1946.) [221

Rothamsted Experimental Station, Harpenden. Report for the War Years 1939–1945. Pp. 269. (Harpenden: Rothamsted Experimental Station, 1946.) 6*s.* [221

Report upon the Needs of European Countries for Scientific Instruments and Laboratory Equipment. Pp. 109. (London: Ministry of Supply (Information Branch), 1946.) [231

Northumberland and Tyneside: a Bibliography. By W. C. Donkin and E. F. Patterson. (Published for the Ministry of Town and Country Planning.) Pp. xvi + 102. (London: H.M. Stationery Office, 1946.) 2*s.* net. [231

Other Countries

Indian Forest Leaflet No. 94: Classification of Silvicultural Ledger Files. Sixth revised edition. Pp. 36. (Dehra Dun: Forest Research Institute, 1946.) 6 annas; 7*d.* [141

The Mineral Resources of Western Australia. Prepared in the Government Mineralogical and Chemical Laboratories. Fifth edition. Pp. 28. (Perth: Government Printer, 1945.) [151

Indian Central Jute Committee. Technological Research Memoir No. 9: The Single Thread Strength of Jute Yarns in relation to Test Length. By K. R. Sen and C. R. Nodder. Pp. 20. 1 rupee; 1*s.* 6*d.* Technological Research Memoir No. 10: The Effect of Moisture on the Strength of Jute Yarns. By K. R. Sen, S. B. Bandyopadhyay and C. R. Nodder. Pp. 10. 6 annas; 6*d.* Technological Research Pamphlet No. 2: Assessment of Spinning Quality. By C. R. Nodder. Pp. 8. 6 annas; 6*d.* Technological Research Pamphlet No. 3: Some Notes on the Strength of Jute Ply-Yarns. By C. R. Nodder. Pp. 8. 6 annas; 6*d.* (Calcutta: Indian Central Jute Committee, 1945–1946.) [161

Anuario del Observatorio Astronómico de Madrid para 1947. Pp. 347. (Madrid: Instituto Geográfico, 1946.) [221

Bergens Museums Årbok. Naturvitenskapelig rekke, 1944. Heft 2, Nr. 7–Nr. 11. Pp. 238. (Bergen: A/s John Griegs Boktrykkeri, 1946.) [221

Annuaire astronomique de l'URSS pour l'an 1947. Vingt sixième année. (In Russian and French.) Pp. 452. (Moscow and Leningrad: Akademii Nauk SSR., 1946.) 75 roubles. [231

All-India Institute of Hygiene and Public Health. General Health Survey: Singur Health Centre. Preliminary Report, 1944. Pp. iii + 78. (Calcutta: All-India Institute of Hygiene and Public Health, 1946.) [231